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[Nature.]

THE THEORY OF "STREAM LINES" IN RELATION TO THE RESISTANCE OF SHIPS.*

(Continued from p. 79.)

III.

In this treatment of the propositions concerning the flow of fluid through pipes, I have at length laid the necessary foundation for the treatment of the case of the flow of an infinite ocean past a submerged body. I have shown these propositions to be based on principles which are undeniable, and the conclusions from which, when in any way startling or paradoxical, you have seen confirmed by actual experiment.

I have dealt with the case of a single stream of uniform sectional area (and therefore of uniform velocity of flow) inclosed in a pipe of any path whatever; I have dealt with the case of a single stream of very gradually varying sectional area and velocity of flow; and I have dealt with the case of a combination (or fagot, as it were) of such streams, each to some extent curved and to some extent varying in sectional area, together composing the whole contents of a pipe or passage having enlargements or contractions in its course; and in all these cases I have shown that, provided the streams or pipe-contents finally return to their original path and their original velocity of flow, they administer no total endways force to the pipe or channel which causes their deviations.

I am now going to deal with a similar combination of such streams, which, when taken together, similarly constitute an infinitely extended ocean, flowing steadily past a stationary submerged body; and here also I shall show that the combination of curved streams surrounding the body, which together constitute the ocean flowing past it, return finally to their original direction and velocity, and can not administer to the body any endways force.

The argument in this case is, in reality, precisely the same as that in the case of the contractions and enlargements in pipes which I have already dealt with; for, in fact, the flow of the ocean past the stationary submerged body is only a more general case of the flow of fluid through a contracted pipe; but, though the cases are really the same, there is considerable difference in their appearance; and therefore I will proceed to point out how the arguments I have already used apply equally to this case.

Every particle of the fluid composing the ocean that passes the body must undoubtedly follow some path or other, though we may not be able to find out what path; and every particle so passing is preceded and followed by a continuous stream of particles all following the same path, whatever that may be. We may, then, in imagination, divide the ocean into streams of any size and of any cross-section we please, provided they fit into one another, so as to occupy the whole space, and provided the boundaries which separate the streams exactly follow the natural courses of the particles.

I before suggested a similar conception of the constitution of the ocean flowing past the stationary body, and there pointed out that the streams forming this system must not only be curved in order to get out of the way of the body, but might each require to have to some extent a different sectional area, and therefore a different velocity of flow at different points of their course. If we trace the streams to a sufficient distance ahead of the body, we shall there find the ocean flowing steadily on, completely undisturbed by, and as we may say ignorant of, the existence of the body which it will ultimately have to pass. There, all the streams must have the same direction, the same velocity of flow, and the same pressure. Again, if we pursue their course backwards to a sufficient distance behind the body, we shall find them all again flowing in their original direction; they will also have all resumed their original velocity; for otherwise, since the velocity of the ocean as a whole can not have changed, we should have a number of parallel streams having different velocities and therefore different pressures side by side with one another, which is an impossible state of things.†

Although, in order to get past the body, these streams follow some courses or other, various both in direction and velocity, into which courses they settle themselves in virtue of the various reactions which they exert upon one another and upon the surface of the body, yet ultimately, and through the operation of the same causes, they settle themselves into their original direction and original velocity. Now the sole cause of the original departure of each and all of these streams from, and of their ultimate return to, their original direction and velocity, is the submerged stationary body; consequently the body must receive the sum total of the forces necessary to thus affect them. Conversely this sum total of force is the only force which the passage of the fluid is capable of administering to the body. But we know that to cause a single stream, and therefore also to cause any combination or system of streams, to follow any courses changing at various points both in direction and velocity, requires the application of forces the sum total of which in a longitudinal direction is *zero*, as long as the end of each stream has the same direction and velocity as the beginning. Therefore the sum total of forces (in other words, the only force) brought to bear upon the body by the motion of the fluid in the direction of its flow, is *zero*.*

I have now shown how it is that an infinite ocean of perfect fluid flowing past a stationary body can not administer to it any endways force, whatever be the nature of the consequent deviations of the streams of fluid. The question, what will be in any given case the precise configuration of those deviations, is irrelevant to the proof I have given of this proposition. Nevertheless it is interesting to know something, at least, of the general character which these deviations, or "stream-lines," assume in simple cases; therefore I have exhibited some in Figs. 26, 27, which are drawn according to the method explained by the late Prof. Rankine.

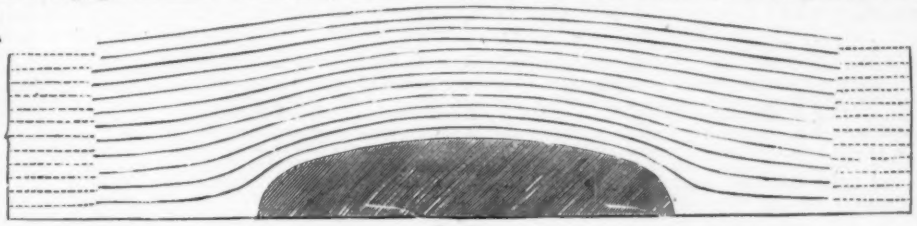

Fig. 26.

The longitudinal lines represent paths along which particles flow; they may therefore be regarded as boundaries of the streams into which we imagined the ocean to be divided.

We see that, as the streams approach the body, their first act is to broaden, and consequently to lose velocity, and therefore, as we know, to increase in quasi-hydrostatic pressure. Presently they again begin to narrow, and therefore quicken, and diminish in pressure, until they pass the middle of the body, by which time they have become narrower than in their original undisturbed condition, and consequently have a greater velocity and less pressure than the undisturbed fluid. After passing the middle they broaden again until they become broader than in their original condition, and therefore have less velocity and greater pressure than the undisturbed fluid. Finally, as they recede from the body they narrow again until they ultimately resume their original dimension, velocity, and pressure.

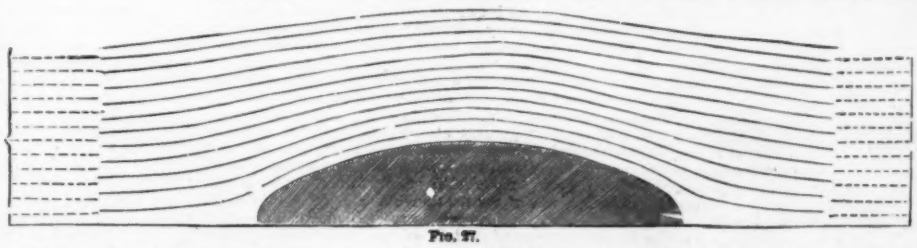

Fig. 27.

Thus, taking the pressure of the surrounding undisturbed fluid as a standard, we have an excess of pressure at both the head and stern ends of the body, and a defect of pressure along the middle.

We proved just now that, taken as a whole, the fluid pressures could exert no endways push upon the stationary body. We now see something of the way in which the separate pressures act, and that they do not, as seems at first sight natural to expect, tend all in the direction in which the fluid is flowing; on the contrary, pressure is opposed to pressure, and suction to suction, and the forces neutralize one another and come to nothing, and thus it is that an ocean of perfect fluid flowing at steady speed past a stationary submerged body does not tend to push it in the direction of the flow. This being so, a submerged body travelling at steady speed through a stationary ocean of perfect fluid will experience no resistance.

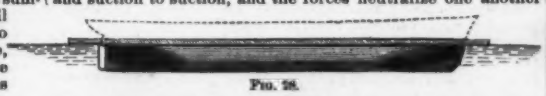

Fig. 28.

We will now consider what will be the result of substituting an ocean of water for the ocean of perfect fluid.

The difference between the behavior of water and that of the theoretically perfect fluid is twofold, as follows:

First. The particles of water, unlike those of a perfect fluid, exert a drag or frictional resistance upon the surface of the body as they glide along it. This action is commonly termed surface-friction or skin-friction; and it is so well known a cause of resistance that I need not say any thing further on this point, except this, that it constitutes almost the whole of the resistance experienced by bodies of tolerably easy shape travelling under water at any reasonable speed.

Secondly. The mutual frictional resistance experienced by the particles of water in moving past one another, combined with the almost imperceptible degree of viscosity which water possesses, somewhat hinders the necessary stream-line motions, alters their nice adjustment of pressures and velocities, and thus defeats the balance of stream-line forces and induces resistance. This action, however, is imperceptible in forms of fairly easy shape. On the other hand, angular or very blunt features entail considerable resistance from this cause, because the stream-line distortions are in such cases abrupt, and degenerate into eddies, thus causing great differences of velocity between adjacent particles of water, and great consequent friction between them. "Dead water," in the wake of a ship with a full run, is an instance of this detrimental action.

So far we have dealt with submerged bodies only; we will now take the case of a ship travelling at the surface of the water. But first, let us suppose the surface of the water to be covered with a sheet of rigid ice, and the ship cut off level with her water-line, so as to travel beneath the ice, floating, however, exactly in the same position as before (see Fig. 28). As the ship travels along, the stream-line motions will be the same as for a submerged body, of which the ship may be regarded as the lower half; and the ship will move without resistance, except that due to the two causes I have just spoken of—namely, surface-friction and mutual friction of the particles. The stream-line motions being the same in character as those we have been considering, we shall still have at each end an excess of pressure which will tend to force up the sheet of ice, and along the side we shall have defect of pressure tending to suck down the sheet of ice. If, now, we remove the ice, the water will obviously rise in level at each end, so that excess of hydrostatic head may afford the necessary reaction against the excess of pressure; and the water will sink by the sides, so that defect of hydrostatic head may afford reaction against the defect of pressure.

The hills and valleys thus formed in the water are, in a sense, waves; and, though originated in the stream-line forces of the body, yet when originated they come under the dominion of the ordinary laws of wave-motion, and, to a large extent, behave as independent waves.

The consequences which result from this necessity are most intricate; but the final upshot of all the different actions which take place is plainly this—that the ship in its passage along the surface of the water has to be continually supplying the waste of an attendant system of waves, which, from the nature of their constitution as independent waves, are continually diffusing and transmitting themselves into the surrounding water, or, where they form what is called broken water, crumbling away into froth. Now, waves represent energy, or work done; and therefore all the energy represented by the waves wasted from the system attending the ship, is so much work done by the propellers or tow-ropes which are urging the ship. So much wave-energy wasted per mile of travel is so much work done per mile; and so much work done per mile is so much resistance.

The actions involved in this cause of resistance, which is sometimes termed "Wave-Genesis," are so complicated that no extensive theoretical treatment of the subject can be usefully attempted. All that can be known about the subject must, for the present, I believe, be sought by direct experiment.

Having thus briefly described the several elements of a ship's resistance, I will proceed to draw your attention more particularly to certain resulting considerations of practical importance. Do not, however, suppose that I shall venture on dictating to shipbuilders what sort of ships they ought to build: I have so little experience of the practical requirements of shipowners, that it would be presumptuous in me to do so; and I could not venture to condemn any feature in a ship as a mistake, when, for all I know, it may be justified by some practical object of which I am ignorant. For these reasons, if I imply that some particular element of form is better than some other, it will be with the simple object of illustrating the application of principles, by following which it would be possible to design a ship of given displacement, to go at given speed, with minimum resistance, in smooth water—in fact, to make the best performance in a "measured mile" trial.

(To be continued.)

* Address to the Mechanical Section of the British Association, Bristol, August 25, 1875, by William Froude, C.E., M.A., F.R.S., President of the Section. Revised and extended by the author.

† In an imperfect fluid it *is* possible to have parallel streams having different velocities and the same pressures side by side with one another, because, in an imperfect fluid, change of velocity may have been communicated by friction instead of by difference of pressure.

* See Supplementary Note C.

ARTIFICIAL MILK.

The *American Journal of Pharmacy* says the best substitute for mother's milk, according to Beno Martiny, is the yolk of chicken egg, which weighs, on an average, fifteen grammes, and when diluted with 57.1 grammes of water of about 100°, and five grammes of milk-sugar, has nearly the same composition as the milk in the first period of lactation. Subsequently, the fat and protein decrease, and to one yolk may be added one hundred grammes of water and six grammes of milk-sugar.

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PROSPECTS OF THE DEPARTMENT OF EDUCATION.

THE ungracious task of prophesying evil is not one that we covet, yet seriously we fear that the institution which we pride ourselves most upon as a people will come most lamely off at the great show. We profess to regard popular education, or rather the widest diffusion of the means of early instruction, as one of our great, if not the greatest of our national virtues. Nevertheless, there is reason to fear that, when the Exhibition is opened, the schools of the land will be found but imperfectly represented.

In one sense, the entire Centennial show will be a representation of our standing as regards popular intelligence, and so will indirectly exhibit the value and influence of our general system of public education.

Nevertheless, a more specific display of our educational resources, processes, etc., will be required, and in this there is danger of a humiliating deficiency. Lacking a national department of education, with power to secure an adequate display of educational matters, the furnishing of this department of the Exhibition devolves upon those who can simply invite contributions from people who can in no way reap a pecuniary reward for their efforts. Only patriotic motives and local pride can act in a case of this sort; and local officers, as a rule, are only too willing to see the calls of patriotism responded to by some one else.

Space has been set apart for this department in the Main Building. In addition, the commissioners hold it desirable that three special buildings be erected and equipped for representing, first, a kindergarten (scarcely to be regarded as a feature of our school system as yet); second, a common school-house; third, a city school-house—the three to cost about $15,000. Contributions to this end have been solicited from school boards throughout the country. We sincerely hope that the money will be forthcoming, and that the proposed models will fairly represent what is best in schools of the kind.

For higher education, there is less risk of failure. The leading colleges and professional schools are able to secure for themselves a reasonable representation, and there is competition enough among them to insure that it be done.

Among the States mentioned as specially active in preparing for this department of the Exhibition are Indiana and Connecticut. The plan of representation adopted by the Centennial Education Committee of the latter State includes twenty-four sections, as follows:

1. A history of the schools of the State, of the school fund and school legislation, and a brief explanation of the provisions of the school laws.
2. Local school histories and reports
3. The school systems of the larger towns and cities, their organization and management, including the full course of study in all the departments, and giving the hours per week for each study.
4. Blanks for records, reports, and registers.
5. Specimens of cards, certificates, medals, etc., used as incentives.
6. Photographs, of uniform size, of the best school-houses, academies, college buildings, and professional schools.
7. Photographs, of a given size, of the interior of the best rooms, showing the pupils at their desks, or in some attitude in their gymnastic exercises, also the arrangement of maps, pictures, etc.
8. Plans of the arrangement of school grounds and outbuildings.
9. Provisions for physical training.
10. Specimens of school furniture.
11. Illustrations of the best methods of ventilation.
12. School apparatus, including globes, maps, geometric forms, gonigraphs, and kindergarten implements.
13. Text-books, catalogue of libraries, and reference-books, including a set of the *American Journal of Education* and other educational works.
14. Historical accounts, and catalogues of all Academies and of the Normal School.
15. History and proceedings of historical, scientific, and literary societies.
16. History and catalogues of each of the colleges of the State.
17. History and photographs of the American Asylum for the Deaf and Dumb, the Whipple School for Mutes, the School for Imbeciles, and the other charitable reformatory institutions of the State which are educational in their character.
18. Work of the pupils in public schools, of eleven kinds, as described above.
19. Similar work of pupils in private schools.
20. A geological map of Connecticut.
21. An educational map of the State.
22. Work of the Chinese students. As the headquarters of the Chinese Educational Commissions are in Hartford, it is fit that the Connecticut branch of the Exhibition should include the work of these most interesting and earnest students.
23. One specimen of every newspaper and periodical published in the State; of dailies, the number issued on Monday, March 1st, is solicited; of weeklies, the issue of the first week in March; of monthlies and quarterlies, the number nearest that date. This proposed collection will be catalogued and bound in volumes, and ultimately returned from Philadelphia and "deposited in the State Library, to be preserved for the next Centennial Exhibition."
24. A complete set of the works issued by the officers and alumni of Yale College.

EGYPT AT THE EXHIBITION.

EGYPT'S entire contribution to the Centennial Exhibition has arrived the first on the ground. Nearly the whole of the exhibit is the property of the Khedive, drawn from the vice-regal museums, farms, and factories, or purchased for the occasion, for which purpose the sum of $100,000 was appropriated. Very few private manufacturers and landowners contributed. Many curious and costly articles, such as weapons and ornaments from Central Africa, jewels, inlaid work in ivory, precious metals, embroideries in gold and silver thread by Arab artisans of Cairo, are taken from the National Museum; the best specimens of agricultural products are from the estates of the Khedive. In the latter department there is a full collection of the products of the Nile Valley, the Oasis, and the Coasts of the Mediterranean and the Red Sea. The display of cotton includes specimens and the crops of the past eight years, with the prices they brought in Alexandria and in Liverpool. Sugar, raw and refined, is the next most important article. Wheat, maize, barley, doura, beans, peas, sorghum, tobacco, indigo, a great variety of fibre plants, all the woods of Egypt, fruits, fresh and preserved, honey, perfumery, chemical preparations, marbles and building stones, are among the other contributions to this department.

Of the catalogue, which contains over 6000 numbers, the *Tribune's* Philadelphia correspondent says: "It is in itself a mine of information about the novel and daring experiment of the Khedive in ingrafting upon a decayed and dormant nationality all the modern improvements of highly-civilized Europe. Statistics are given of the farms, factories, laboratories, schools and charitable institutions that have been established since he began his remarkable effort to awaken his country from its sleep of centuries. The new arts and industries imported from France, Germany, and America, and made to take root by the will of one man, contrast strangely with the barbaric splendors in architecture and apparel, whose forms and decorations come down from the reign of the Khalifs, and with the primitive furniture and utensils of the Fellahs, unchanged since the days of the Pharaohs."

The Egyptian section in the main building will present a strange mingling of the splendors of the East with the plainer and more practical appliances of modern civilized life. There are saddles of curiously embroidered leather ornamented with massive gold, cimeters with jewelled hilts, furniture inlaid with ivory, silk curtains, and ladies' jackets heavily embroidered with gold thread, and there are also drain pipes, shovels and hoes and axes, books for the blind, and drawing by pupils in the polytechnic school. By the side of the ancient papyrus one sees the modern newspaper, the hippopotamus hide contrasts with good, every-day calf-skin, the chibouk and nargileh with the Parisian cigarette; porcelain of European style with ancient red pottery. There is no end of curious articles from Soudan, Darfour, Abyssinia, Uganda, and even from the country of the Dwarfs.

The localities from which all the Egyptian products come are given in a large map of "Egypt in the Centennial Year of the American Republic," prepared expressly for the Exhibition.

INTERNATIONAL CONGRESSES AT THE CENTENNIAL.

IN a long letter to the *Herald*, the Hon. John Jay repeats his oft-repeated proposition of an assemblage of International Congresses as a part of our Centennial celebration. The fields to be covered by these congresses comprise all the great departments of practical inquiry having for their object the improvement of humanity. Among them he mentions education, international patent right, international copyright, agriculture, forestry, medicine and surgery, engineering, architecture, mining, telegraphy, photography, music, art museums and art exchanges, meteorology, international law, benevolent institutions, political economy, and others. He argues that such congresses are a feature of international exhibitions especially fitted to develop their full intellectual benefits, in harmony with the idea that the exhibition should be, as Prince Albert expressed it, "a proof and a living picture of the height of civilization and the development of mankind." "For America such an assemblage in our midst of the foreign masters of modern science would have further advantages which no thoughtful American can overlook, in the appreciative knowledge which they would carry back of the capacity and resources of the Republic in progress, in education, science, and art, the character of its people and their continuous development—considerations bearing directly upon our national prestige, credit and influence, our intellectual and scientific rank, the incentives to emigration and the confidence in our future. Such a gathering of the recognized leaders of modern civilization to 'consider questions,' as a European journal expresses it, 'having an interest for all humanity,' would of itself raise the Exhibition far above the idea sometimes entertained of it as simply a gigantic fair; would give to it an intellectual character beyond that of any similar exhibition in the past, and would make our Centennial celebration of unexampled dignity in the history of the world, with new proofs, in the record of its congresses, of the happy fruits of international harmony."

The absence of national rivalries and the fear of war, which in Europe hang "like a cloud over the continent," gives to our country, he justly argues, the advantage of a neutral ground, separated from Europe and its quarrels, and devoted to peace by its traditional policy; and these features, combined with a growing confidence in our peaceful and continuous development, afford to the Republic as a suitable place for international congresses an advantage not to be overlooked.

THE OHIO CENTENNIAL BUILDING.

THE Ohio building on the Centennial grounds will be 40 ft. square in the inside, two stories high, with an attic, a hall 9 ft. wide through the centre, on one side of which is a ladies' parlor, 25½ by 15½ ft.; in the rear a dressing-room, wash-room, and closets; on the other side are an office, gentlemen's room and conveniences for the press. Registers for recording the names of visitors and exhibitors will be kept in elegantly-bound books, which, after the Exhibition closes, will be deposited in the State Library, and in after years will become of interest to examine. The roof of the building will be of metal, and painted with iron-clad paint. The foundations are finished, and it is expected that the whole will be completed by the first of May next. Twenty-four different stone quarries, embracing the leading sandstones of the northern and southern portions of Ohio, as well as Dayton, Columbus, and Springfield limestone, will be represented in the structure.

EXHIBITION NOTES.

THE Main Exhibition Building will pass from the hands of the contractors to the Board of Finance about the first of February. The Art Gallery will be transferred to the care of the Board early in March. The Machinery Building having been in the possession of the Board some time, and the Horticultural Hall for a shorter period, there will remain only the Agricultural Hall in the hands of the contractors. The early completion of the last is promised.

CHARLES J. STILLE, LL.D., provost of the University of Pennsylvania, has accepted the office of Chief of the Bureau of Awards.

IN addition to the provision for the Educational Department in the Main Building, the Commissioners hold it very desirable that one or more model school-houses be erected to represent the working of our common-school system. Three buildings are wanted, to cost not more than $15,000 in all. The proposed buildings are: the kindergarten, 20 x 26 feet, of one story; the common school-house, 20 x 30 feet, of one story; the city school-house, 30 x 40 feet, of two stories. It is expected that furniture and apparatus would be supplied by manufacturers and dealers.

APPLICATION has been made for permission to set up on the Exhibition grounds a Jewish restaurant for the use of those who adhere to the dietary laws of the Hebrews. Ministers of several Hebrew congregations have indorsed the application, which will undoubtedly be granted. It is stated that from fifty to seventy-five thousand Israelites will visit the Exhibition, for the most of whom a special eating-place, such as the one proposed, will be a real necessity.

WRITING from Hot Springs, Arkansas, General Hooker gives the following evidence of the spirit of that portion of the South toward the Centennial: "During the dark days of the rebellion, Mr. Lincoln addressed a communication to the Governor [Rector] of Arkansas, asking how many men and how much money his State would furnish for the war. The reply was, 'Not a man or a dollar.' Now the State is almost crazy in volunteering to form a regiment to visit your Centennial at their own expense; and the regiment, I am happy to say, was nearly full in two days. It seems to me that the hearts of these gentlemen can not be far removed from the right place. When the Centennial has been made proper use of by our people, as I know it will be, the war may be considered as fairly over, the tomahawk buried, and, I may add, the 'red shirt' and its advocates with it."

THE general passenger agents of the four trunk lines and the principal Western railways, at a conference in Philadelphia, decided to discontinue at once and permanently all arrangements with tourist agencies. The travelling public are informed that this action is designed solely to protect them from middlemen. It is said that the leading steamship lines have taken similar action.

THE *Herald* insists that a Chess Congress should be a feature of the Exhibition. "At the International Expositions at London, Paris, and Vienna, congresses of the kind attracted the attention of the world. When we consider that America has produced in Paul Morphy the greatest player of the world since La Bourdonnais, the importance of maintaining our reputation in the game is clear. We have many fine players who would take part in a tournament, and some of the greatest professors of chess in Europe would undoubtedly cross the ocean to conquer new worlds."

A COMPANY is organizing, with a capital of $100,000, for the purpose of displaying Spear's Travelling Sidewalk at the Exhibition. It is proposed to set up on the grounds a model road half a mile long, to be operated by stationary engines, and run at a speed of fifteen or twenty miles an hour. The transfer seats and other appliances will be of the same size as those intended for general use.

JAPANESE mechanics, with nineteen car-loads of materials, have arrived, and are busy setting up the government houses, temple, etc., in the Park. In the construction of these buildings, not a nail will be used.

AN American, who spent five months at the Vienna Exhibition, remarked after its close that he felt as if he had gone around the world and had observed the manners and customs of all countries. "Show me the books you read," said a wise man, "and I will describe your character." Show us the articles a nation makes—the machines it invents, the pictures it paints, the furniture and apparel it uses, the food it prepares—and we can judge of its arts, its laws, its domestic life. The visitor to the Centennial will see far more of the world than Phineas Fogg saw when he made his eighty days' journey.

AMONG the relics contributed by Newport to the Centennial Fair which the ladies of Providence have been conducting, is a doll believed to be the oldest in the country. It is of wax, about ten inches high, and has grown yellow with age until it looks like a corpse. It was imported from Paris as a model of the fashions of the day, and was bought in Philadelphia by Benjamin Bourne, of Bristol, England, who was a member of Congress from 1790 to 1796. The doll was given to his niece, Miss Lillie E. Turner, daughter of Dr. Peter Turner, a surgeon in the Revolutionary army. The doll's eyes still move, and it still wears the finery in which it crossed the ocean to show the ambitious dames of the young republic how their Parisian sisters were wont to dress.

ONE of the curiosities of the Egyptian collection is an ancient royal bed. It stands about a foot high, and is supported by four thick heavily wrought legs. It is made of reeds very closely twined; no doubt a fine bed in its day, but not many of our forty million American sovereigns would covet it for a night's repose.

THE paper-boat-builders, Waters & Son, of Troy, have made six boats for the Exhibition. They comprise a six-oared gig, a four-oared shell, a double scull, two single shells, and one pleasure-gig. The boats are models in their way.

PROF. HAYDEN, Chief of the U. S. Geological and Geographical Survey of the Territories, is preparing an exhibit of the geology, topography, mineralogy, botany, and ethnology of Colorado, New-Mexico, Arizona, Wyoming, Utah, and Montana, to comprise, besides photographic and lithographic illustrations of scenery, etc., a series of plaster-casts in miniature of the most important ranges and groups of peaks of the Rocky Mountains, showing their relative altitudes and

geological formations in appropriate colors. There is also being prepared a collection of miniature villages in plaster, showing in detail the mode of living of that extinct aboriginal people of Southern Colorado and Arizona known as the Seven Moquis Pueblos or Cliff-Dwellers. These villages lie midway between the Rio San Juan and the Little Colorado rivers, about one hundred miles west of Fort Defiance. The principal villages, and those which have attracted so much attention through the antiquities collected in and about their ruins, are Tequa, Se-chum-e-way, Moqui, Moo-sha-neh, Shepaul-a-wee, Shong-a-pah-wee, and Oraybe. These ruins, inhabited not less than four centuries ago, are still in a fair state of preservation. They embrace towers, walled works of defence, store-houses, and fortified dwellings containing as many as 175 rooms, with large cisterns, centrally located, from which to obtain supplies of water during the evidently frequent and vigorous sieges laid by the warlike and predatory nations of the North.

MR. JOHN HATCH, of California, has spent many years in making a collection of specimens of the precious ores of the Pacific Slope, Mexico, Central and South America, Australia, China, and Japan. His collection numbers between 12,000 and 15,000, and he is preparing them for exhibition at the Centennial.

THE Centennial Committee of the American Dairymen's Association, at their late meeting at Rome, N. Y., recommended the erection of butter and cheese factories on the Exhibition grounds. A committee was appointed to raise $10,000 for this purpose.

THE New-Haven (Conn.) Board of Education have voted to have the New-Haven schools represented at the Centennial Exhibition. The plan now is to have every pupil in the city make three specimens of free-hand drawing under the instruction of the teacher, from which to make selections sufficient to form a good-sized volume, and in the same manner specimens of map-drawing and penmanship; also to furnish blank reports, etc., showing in a general way the manner of conducting the schools.

THE contract for supplying the tanks for aquaria display in Agricultural Hall has been awarded. The tanks will be situated in the north-western part of the building, and will comprise some twenty or thirty in number, the largest twenty feet in length by seven feet in width. The water is to be kept clear by being filtered as it is supplied to the tanks.

A FULL-SIZED terra-cotta cast of the marble group of "America," sculptured by Mr. Gibson, and placed at one of the angles of the nearly completed Albert Memorial, in Hyde Park, London, will be sent to the Art Gallery in Fairmount Park.

THE *Tribune* is confident that the Exhibition will bring about a rapid revival of business by virtue of the confidence and patriotic enthusiasm it will awaken. The panic served a good purpose in checking a mania for reckless speculation that was the offspring of a long period of unexampled prosperity, and the hard times that followed have enforced useful lessons of economy. The country has taken a two-years' rest; its breathing-spell has lasted long enough; it is ready to start afresh, and only lacks confidence in itself to run another course in the race of material progress. This confidence, we believe, the Centennial will leave behind it as a legacy. When we have gathered the products of our empire and set them forth in orderly array beside those of all the other nations of the earth, we shall better appreciate our resources. We are more bountifully endowed by nature than any other land the sun shines upon. We are young, strong, inventive, and quick-witted. No oppressive government cripples our industry; no hostile neighbors threaten us; we have not the burden of a standing army to carry. In comparing our condition with that of other peoples, we shall see that we have the advantage over them in most important respects, and if in some things we are lacking—if our fine arts are backward, our manufactures wanting in taste, our agriculture unscientific, or our domestic life wasteful—we shall see our shortcomings so plainly by contrast that we shall make a great effort to remedy them, and thus by perceiving wherein lies our weakness, we shall augment our powers. When the Centennial is over, the whole nation will feel refreshed and encouraged.

A SPECIAL committee of the manufacturers of mowers and reapers of the United States have arranged with the Bureau of Agriculture for a harvesting display at the Centennial.

THE following plan of operation has been adopted by the Centennial Boarding-house Agency for the accommodation of visitors to the Exhibition: Coupon tickets will be placed on sale by the agency in various parts of the country, which will be received by the householders in paying for board furnished. The purchaser will be met while on the train approaching the city by a messenger of the agency, who will hand him a card as a letter of direction and introduction to the quarters assigned him, which he will find vacant and ready for his reception. The whole system of rooms will be under one general management, the city being divided into such number of districts (each in charge of a superintendent), as may be required by the proper handling and transaction of business. From the facilities already at the command of the agency, it is expected that quarters can be provided for from 30,000 to 40,000 persons daily. The agency agrees to furnish comfortable accommodation in private houses, at a cost ranging from $2 to $2.50 a day, to include two full meals, breakfast and supper, and clean lodgings.

THE Centennial Board of Finance have appointed Mr. Wm. J. Phillips to be general manager and director of the telegraph system to be placed in operation during the Exhibition. Mr. Phillips is the Superintendent of the Police and Fire-Alarm Telegraph Department of Philadelphia.

THE Egyptian Commission is composed of the following nembers: His Highness Prince Mohammed Tawfic Pasha, President; His Excellency Cherif Pasha, Minister of Commerce, Vice-President; H. Brugsch Bey, Commissioner-General and Secretary; General Stone; Mahmoud Bey, Astronomer; Mariette Bey, Director of Museums; M. Gastinel Bey, Professor in the Medical School. Brugsch Bey is the Director of the Museum of Egyptian Antiquities, and was the Commissioner-General of Egypt at the Vienna Exposition. He is a learned Egyptologist, is the author of several books, and is well known in literary and scientific circles in Europe. Formerly he was a professor in the University of Göttingen. He is pleased with the preparations for the Centennial, which he regards as eminently practical, and he characterizes the management as exceedingly energetic and efficient.

THE Prince Imperial of Germany, Frederick William, has decided not to visit the Exhibition for several reasons, the most important of which is that the condition of the Emperor's health renders the absence of the heir to the throne inadmissible.

As the space set apart in the Exhibition Building for the American book trade has been found to be inadequate, it has been proposed to double the space for books by erecting an ornamental structure of iron, forming a second floor over the entire space, reached by staircases on either side. A willingness has been expressed by the leading publishers to share the expense of five thousand dollars for this structure.

THE Secretary of the British Commission has received a letter from Mr. S. A. Waterer, of Knoss Hill Nursery, Woking, Surrey, England, saying that he purposes to make a fine display of rhododendrons. He asks that he shall be provided with a tent, 150 by 50 feet, with a supply of water and hose, and that the ground shall be prepared in accordance with a plan to be submitted by himself. The plants will probably arrive about the first week in April, and would be planted in the tent about the second week in May. The duration of the exhibition will be about three weeks.

THE Paris Ministry of Public Works will send to the Exhibition plans of the recent public works in that city. The Municipal Council will send the models of the squares and public buildings which figured at the Vienna Exhibition.

THE selection of marksmen for the British team to take part in the Centennial rifle tournament will be made in the following ingenious manner: It is proposed to bring over a team of eight, with a reserve of four marksmen. These are to be selected after competition. The care taken in these tests shows the desire of the captain and council to secure only the best rifle talent. The first of the competitive trials will take place early in the spring, and the second soon after the Wimbledon meeting in July. Each of these competitions will last two days, each day's work to consist of fifteen shots each at 800, 900, and 1000 yards, without sighting shots, and with no practice at those ranges for two days preceding each trial. Each man's average will be determined by taking the three best out of the four scores made. The sixteen competitors having the highest scores will select the two first members of the team. These two will select a third, this trio a fourth, and so on until the final twelve are chosen, the captain and adjutant to be ex-officio members of these successive committees of selection. After their choice the twelve marksmen are to shoot together for two days for drill as a team and for accurate comparison of rifles. This subordination of the individual marksmen to the team was the distinguishing feature of the American riflemen when abroad last summer, and the lesson then taught of the advantage of united effort over individual endeavor has been taken up most enthusiastically by the riflemen of the kingdom.

THE Hon. John Jay, late American Minister at Vienna, insists that it would be the proper thing to open the Exhibition free on certain days. By this arrangement, the Exhibition would, in the fullest sense, inure to the general welfare, with no restriction of the pleasures or benefits to be derived from it to those classes who can afford to purchase the enjoyment. He claims that the reasonableness of such an arrangement, its accord with the spirit of our institutions, and with the spirit of the occasion, and its profound importance to the country, in reference especially to our youthful population, and the advantages to be derived from the visits of schools and guilds and societies, seem too obvious to need discussion.

LOCOMOTIVE FOR THE WESTERN RAILWAY OF FRANCE.

OUR engraving gives a longitudinal section and sectional plan of the locomotive. The engine possesses a special interest from the fact that it is of a class which constitutes the sole type adopted on the Western Railway of France since the year 1857, for all kinds of trains run at speeds of from 20 to 40 miles per hour.

The first twelve locomotives of this class, says *Engineering*, constructed in 1857, had boilers with flush-topped fire-boxes, and the length of the wheel-base was 12 ft. 3¼ in. In the next lot of twenty engines built in 1860, the leading wheels were placed 9¾ in. further forward, and the tubes were similarly lengthened, the length of both the tubes and wheel-base being made 13 ft. 1½ in. At the same time the cylinders were shifted forward, the piston-rods being lengthened so as to keep the connecting-rods of the same length as in the earlier engines. Stitl later, in 1864, a further number of these engines were constructed, in which the diameter of the boiler-barrel was slighty reduced and the fire-box made with the crown raised above the level of the barrel. The pattern thus arrived at has since been adhered to, and altogether there were last year 130 of these engines in service, of which 54 were of the latest type.

The engine has inside cylinders, and all the wheels are in front of the fire-box, the driving and trailing wheels being coupled. The cylinders are 16.56 in. in diameter, with 22.05 in. stroke, and the coupled wheels are 5 ft. 10.9 in. in diameter, whilst the diameter of the leading wheels is 3 ft. 3¾ in. The total wheel-base is, as we have already stated, 13 ft. 1½ in., the distance between the centres of the leading and driving wheels being 6 ft. 8 in., and between the centres of the coupled wheels 6 ft. 5½ inches. The tractive power of the engine is from the above dimensions $= \frac{16.56^2 \times 22.05}{70.9} = 85.29$ lb. for each pound of effective pressure per square inch on the pistons.

The centre of the trailing axle is but 4.33 in. in front of the fire-box, so as to lessen the overhang at the trailing-end as much as possible, and, notwithstanding this overhang, the engines are found to run very steadily at speeds up to 60 miles an hour. The load on the leading wheels being but small—namely, 8 tons—it is desirable as far as possible to avoid all side-play at the leading end, and, to assist in securing the desired steadiness, the leading axle-boxes are fitted with adjustable bearing-pieces which can be set so as just to bear against the ends of the axle.

A prominent feature in the engine is the construction of the driving-axle. As will be seen from the various views already referred to, and from the detail view on the next page, this axle is constructed on the "half-crank" system introduced in the United States by Mr. Matthias W. Baldwin in 1834. Thanks to the mechanical appliances now available, and the recourse which can be had to powerful hydraulic pressure to force the wheels on their wheel-seats, a thoroughly substantial job can nowadays be made of such an arrangement, and we understand that on the Western Railway of France these axles have given every satisfaction. Up to last year but one of those put in service in 1865 and 1866 had been taken out in consequence of a fracture, and this axle, which was put on the road in 1867, had run over 185,000 miles before it failed. This axle is very substantial, the crank-bearing being 7.48 in. in diameter by 4.33 in. long, the centre-bearing 7.48 in. in diameter by 9.84 in. long, and the crank-arm measuring 6 in. by 8.66 in. The part which enters the wheel-boss is 8.66 in. in diameter for part of its length and 7.48 for the remainder, and it is secured by a steel key measuring 1.65 in. by 1.1 in. The continuation of the axle outside the wheel is similarly keyed, this extension of the axle not only forming the outside bearing, but also carrying—as shown in the sectional plan—the eccentrics and the outside cranks by which the driving and trailing wheels are coupled. In connection with the coupling it is to be noticed that since 1865 it has been the practice on the Western Railway of France to place the outside cranks in the same direction as the inside cranks, instead of opposite to them, as is usual. This is an arrangement which has for many years been used in England by Mr. Stroudley—now of the London, Brighton, and South Coast Railway—and it is found to effect a material saving in the wear of axle-boxes and axle-bearings in consequence of the reduced pressure upon the latter. The only inconvenience attending the plan is the increase in the size of the counter-weights which it necessitates.

Owing to the construction of the driving axle the cylinders are placed wide apart, the distance between their centres being 3 ft. 2.6 in. The valve chests are outside them. The two cylinders are bolted together so as to clip between them a frame-plate which extends down the middle of the engine to about midway between the driving and trailing axles, where it is united to a substantial cross-stay. This central frame is also connected to the side-frames by the motion-plate. Unlike the central frames fitted to some of the English broad-gauge locomotives, and which only serve to steady the crank-axle, this frame in the engine we are describing carries a portion of the weight, the axle-box fitted to it being connected to a spring below. The rubbing-pieces between which the axle-box works are fitted with two wedge adjusting pieces, one in front and one behind the axle box. The rubbing-pieces on the outside frames, on the other hand, are fitted with wedge-pieces on the front side only. With the exception of the case of the central bearing just spoken of, the springs for all the axles are placed above the frames, as shown in the side elevation.

The pistons are of cast-iron and fitted with two rings sprung into place. The guide-bars are of steel and the cross-head is fitted with steel shoes. The mode of connecting the piston-rod to the cross-head is peculiar, as will be seen from the longitudinal section and sectional plan. The end of the piston-rod is enlarged so as to form a conical head expanding towards the end, which enters a correspondingly formed hole in the crosshead. This hole is larger than the piston-rod head, so that after the latter is in place there can be introduced a kind of circular key in two halves which fills up the hole. By means of the transverse cotter shown, the piston-rod head is then forced back into tight contact with these keys, and is thus secured. The connecting-rod is made with a solid eye, bushed with brass, at the small end, but the bearing surface afforded appears to us small for a non-adjustable bearing of this class. The large ends are made with caps bolted on, as shown in the longitudinal section.

All the stuffing-boxes about the engine are fitted with metallic packing constructed on the Duterne-Dallot system. The valve-gear, which is outside, is of the lifting-link type, and its arrangement is clearly shown in the side elevation and sectional plan. A little detail worth notice is the mode of fixing the slide-valves on their spindles. As will be seen from the sectional plan, the buckle of each valve abuts on one side against a collar on the spindle, while against the other side there presses a sleeve which envelops the valve-spindle, this bush passing out through the front stuffing-box of the valve-chest, and being secured by a nut at the end of the spindle. This arrangement has been adopted to do away with all screws within the valve-chest. The engine is fitted with screw reversing gear as shown.

The boiler barrel is 3 ft. 10 in. in diameter outside the smallest plate, and the fire-box casing is 4 ft. 7½ in. long, and 4 ft. 1½ in. wide. The inside fire-box is 3 ft. 10½ in. long at the top, and 4 ft. 0¼ in. long at the bottom, and 3 ft. 6⅝ in. wide, while the height of its crown above the grate is 4 ft. 7½ in. The fire-box stays have holes through them, they being made of hollow rolled bars. The boiler contains 156 tubes, 1.97 in. in diameter outside, and 13 ft. 1½ in. long between tube-plates, these tube-plates giving a heating surface of 1055.1 square feet, which, added to 79.3 square feet of fire-box surface, makes the total heating surface 1134.4 square feet. Tlie fire-grate area is 13.35 square feet, and the chimney is 16½ in. in diameter. The proportions of the heating surface, etc., are thus as follows:

Ratio of heating surface to grate area	85 : 1
" sectional area of tubes to grate area	1 : 5
" sectional area of chimney to grate area	1 : 9

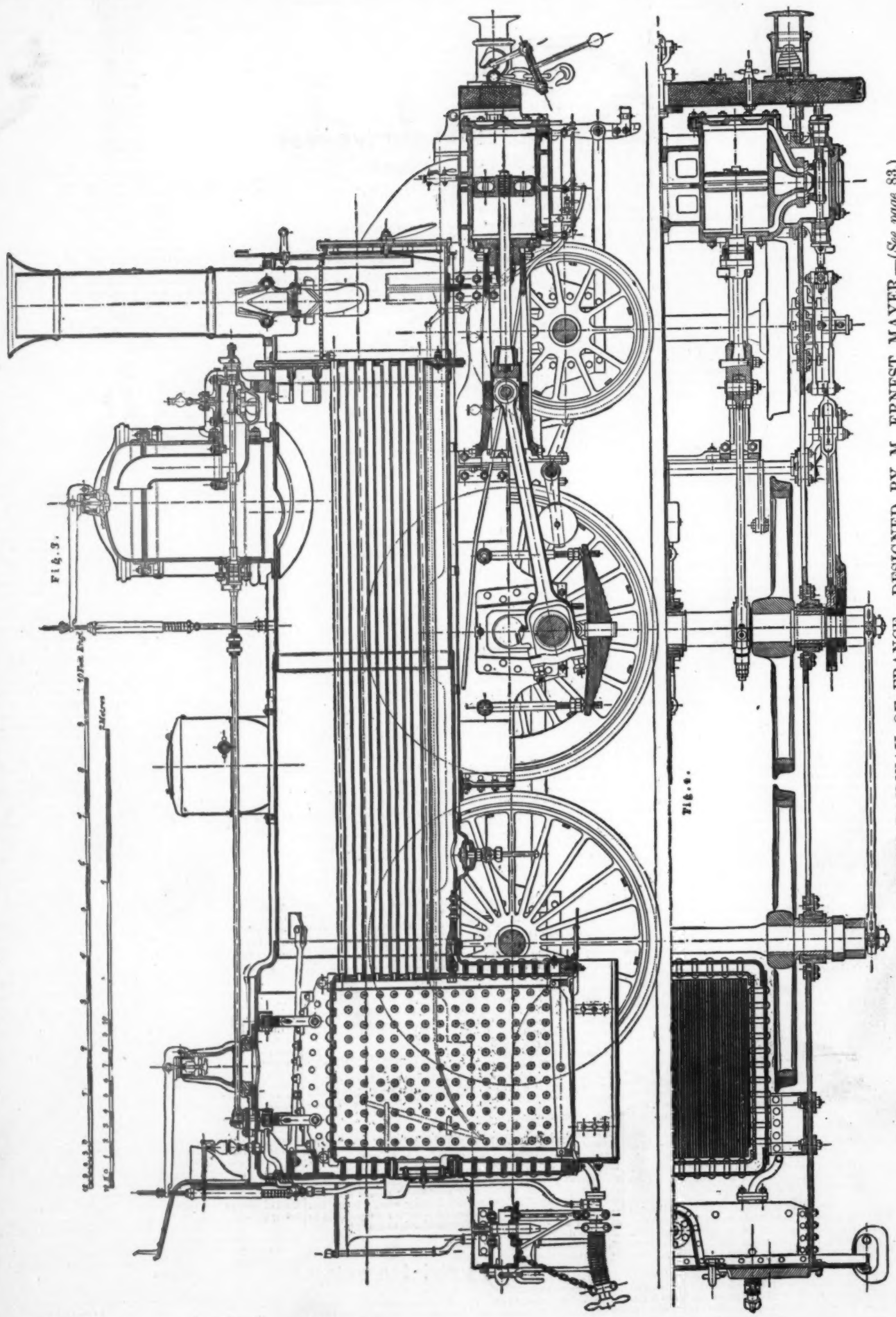
The boiler is supported at the smoke-box, at each of the transverse frame-stays, and by sliding supports at the sides of the fire-box casing, as shown by the several transverse sections. On the barrel near the front end is a very capacious dome, 30.55 in. in diameter, the regulator being fixed to the outside of this dome as shown in the longitudinal section. In the earlier engines of the type we are describing, the regulator was placed within the dome, but the present arrangement was adopted for getting readily at the valve. The smoke-box is provided with a screen for arresting sparks, as shown in the longitudinal section, and the blast-pipe has an adjustable nozzle of the pattern so largely used on the Continent. The boiler-pressure carried is 128 lb. per square inch, and the volume of the water-space is 105.6 cubic feet, and of the steam-space 54.8 cubic feet.

The engine is fitted with the Le Chatelier counter-pressure brake arrangement. Amongst the minor details of the engine we may notice the plan of providing each safety-valve with a kind of anchor-bar slung to it so as to prevent the valve from being blown away in the event of a spring balance failing, or the pressure being removed by some other cause. The arrangement is shown in the longitudinal section.

The weight of the engine we have been describing is 31 tons empty and 34 tons in working order, the latter weight being distributed as follows:

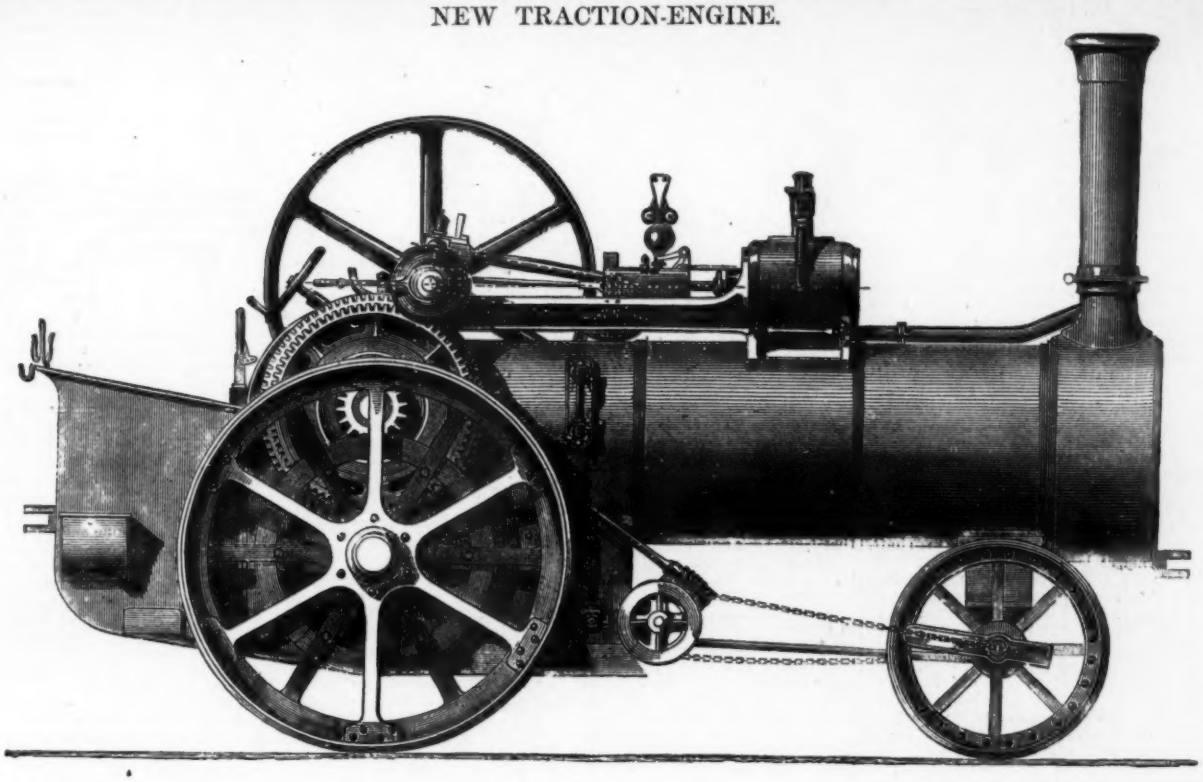
	Tons.
On leading wheels	8
" driving "	13
" trailing "	13
Total	34

Altogether the engine we have been describing forms an interesting example of locomotive practice, and it includes features which are well worthy of examination.



LOCOMOTIVES OF THE WESTERN RAILWAY OF FRANCE.—DESIGNED BY M. ERNEST MAYER.—(*See page* 83.)

NEW TRACTION-ENGINE.



NEW TRACTION-ENGINE.

THE reward of ten thousand dollars offered by the State of Wisconsin (published in *Scientific American*, January 29th, 1876), for the best form of road locomotive lends a special present interest to the subject, and we therefore reproduce from *Engineering* one of the latest and best examples of British practice in road locomotives. This is a 6-horse power engine, by Messrs. Robey & Co., of Lincoln. Messrs. Robey, to relieve the boiler of the strains due to the working of the engine, have interposed between the cylinder and the crankshaft a cast-iron bedplate, one end of this bed forming the cylinder cover, while the other carries the crankshaft plummer blocks. In the case of their portable engine, where the cylinder is over the firebox end of the boiler, the crosshead guides and the exhaust-pipe are cast solid with the bedplate, while the latter takes a sliding bearing at the crankshaft end upon two brackets fixed one on each side of the boiler, one of these brackets having the pump made in one piece with it. In the case of the traction-engine the bedplate has the crosshead guides cast solid with it, while, as in the case of the portable, the bed from its shape forms a receiver for any oil dripping from the moving parts.

In the traction-engine the expansion of the boiler is accommodated by leaving the crankshaft end of the bedplate free to move between the horn-plates, it being held to them by a plate on each side. These plates are made fast to the bedplate, and slide horizontally in slots cut in the horn-plates. The horn-plates reach the whole depth of the firebox, and are deeply flanged outwards, on both sides, for strength, and for attachment to the boiler and water tank. The second motion shaft is carried in a U-shaped casting let into the horn-plates, and stretching between them, acting thus as a stay and distance piece. The main axle is also carried by the horn-plates, which also form the sides of a part of the water-tank. The usual arrangement of steerage gear is modified, the chains being attached to the extreme ends of the axle, by means of grooved castings, so curved as to keep the chains tight in all positions, and facilitate steering. The leading wheels, it will be noticed, are set to a narrower gauge than the driving wheels. The engine is very completely equipped, having water-lifter (injector type) for filling the tank from roadside ditch, etc.

The driving wheels have the arms arranged in two sets, each set of arms being welded to a plate at the centre, which is bored out and fitted with the boss, the rivets holding it up, thus having no shearing strain on them. By the arrangement of the arms in sets, if one arm gets broken the whole set can be removed and a new arm welded on, which is impossible if the arms are cast in the boss.

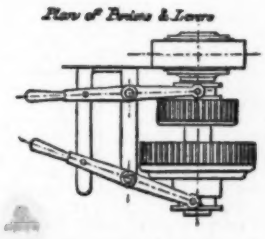
The engine is fitted with two speeds, and the arrangement of the clutches is shown by the detail views. It is also provided with a neat form of high-speed governor for use when the engine is employed for thrashing, etc.

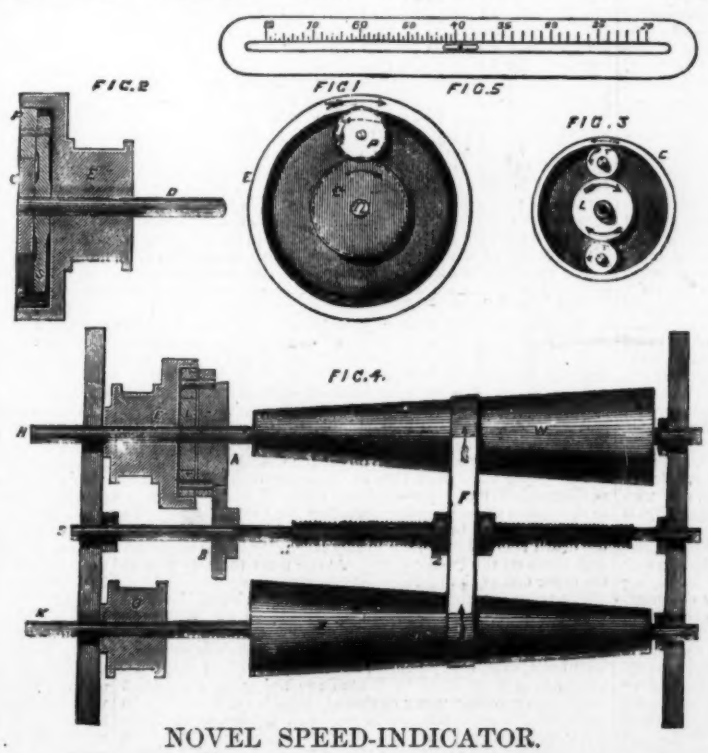
[Engineer.]

NOVEL SPEED-INDICATOR.

By CHARLES E. MOSS, Dublin.

IN this indicator the object aimed at is to establish an equilibrium between known and unknown speeds, and when this is obtained the reading from the indicator or dial gives the number of revolutions per minute.





NOVEL SPEED-INDICATOR.

Fig. 1, of which Fig. 2 is a section, illustrates the principle. D is a shaft driven by a clock at, of course, a uniform speed; this is the standard for reference. Fixed on the shaft D is the toothed wheel C; this gears into the planet-wheel P; the wheel E revolves freely on the shaft D; it is driven by a belt from the engine—whose speed is desired—and in the opposite direction to the shaft D; its front face forms an internal toothed wheel, and the planet-wheel P gears into it also; S is a disc revolving freely on shaft D; it carries the pin which supports the planet-wheel P. The action of the instrument is this—when the wheel C drives the planet-wheel P at the same speed as it is driven by the internal toothed wheel E, the planet-wheel remains stationary, but if the speed of E be 41 teeth and the speed of C 40 teeth, then the planet-wheel will make one revolution per minute forward, or should the speed of E equal 39, then the planet-wheel will revolve backward one revolution per minute.

For engines, locomotive, marine, and mill, ordered or made to run at a fixed speed, this simple system forms a sufficient indicator, for one can tell at sight if the engine is going fast or slow, for the planet-wheel is stationary so long as the revolution of the engine corresponds with the clock.

For variable speeds there are certain additions as shown in Fig. 4. E is the wheel driven by the engine and the shaft and cone K is driven by the clock; there are two planet-wheels here, as shown in Fig. 3; this balances better; in section they are seen at T, Fig. 4. The toothed wheel L is a fixture on shaft H, and gears into the planet-wheel T; they are supported on pins carried by the disc A, which also forms a toothed wheel and gears into the toothed wheel B fixed on the screw-shaft S. The wheels E and A, Fig. 4, are of course free on the shaft H. The belt F drives the cone W, and the block Z on the screw-shaft carries the belt-fork. In Fig. 3 when the speed of L = speed of E, then the planet-wheels are stationary, and that their speeds may be equal, L makes two revolutions for one of E, as that is the proportion of their diameter.

The action of system Fig. 4 is this: The clock drives the shaft K K at say 40 revolutions per minute, and suppose the engine to be running 40 and driving wheel E at 20, then the belt F being in the middle of the cones the system is in equilibrium, and the indicator carried by the belt-fork block Z will point to 40, as seen in Fig. 5. Should the speed of the engine increase 10 revolutions, the planet-wheels will make for 10 revolutions per minute in the same direction, and through the toothed wheels A and B drive the screw-shaft S which carries the belt-fork; the belt F is drawn towards B, and the shaft H is in consequence driven at an increased speed; it therefore more nearly agrees with the speed of the engine. Now, the planet-wheel disc A revolves at the difference of the two speeds backwards or forwards, be the speed less or more. The speed of A is therefore reduced, but nevertheless continues to revolve at a constantly decreasing speed, still drawing on the belt F until an equilibrium is established by the planet-wheels coming to rest, and as the block Z carries the indicator, the speed of the engine is read off on the scale, Fig. 5, which fits immediately over the screw S S.

The length of the cones V and W may be extended indefinitely to increase the range of the scale, and a dial on the screw-shaft will indicate fractions of a revolution. Should the speed be more or less than the range of the scale, then the pin in the block Z, which engages with the screw, works out of gear at either end, and spiral springs cause it to engage again as soon as the screw revolves the other way.

EXAMPLES OF THE CRYSTALLIZATION OF WROUGHT-IRON.

By JOSHUA ROSE.

IN the year 1853, the chain of a crane employed for lifting locomotives at the Ashford Works in Kent, England, was taken from the crane to be annealed, and an old and well-known practical mechanic cut off two of the end links and handed them to me, saying, "Take that to the vice and see how easily you can break a link with the hammer; then take it to a blacksmith's fire, heat it to a low red heat, allowing it to cool in the ashes, and then try to break a link, and you will have received a lesson on the granulation of iron that you will not easily forget." These instructions were implicity followed with the result that both of the links broke short off at the first test, the fractures showing a highly crystallized surface before being annealed. To test if the crystallization was equal at all parts of the links, or had only occurred where the welding of the links (in the manufacture of the chain) had taken place, each link was then fastened in the vice, slightly nicked with a chipping-chisel, and then broken with one blow of the hammer. The pieces of the links were then annealed, and were afterward bent backward and forward, showing no signs of fracture. They were then cut about one third through with a chipping-chisel, and bent back and forth by blows with the hammer until they broke, the fibre of the iron appearing as long and splintered as that of a broken piece of wood, and not showing in any part any evidence of crystallization.

In the year 1858, the writer was called to a sugar estate on the west coast of the Essequebo River to repair an engine which had broken down, and among the repairs it was required to provide a shaft for a cane-crushing roller, which shaft had broken in two inside the roller. The shaft was 6 inches in diameter, 5 feet long, and had a fixed bearing of about 8 inches in length at each end of the roller, and was secured therein at each end by four steel keys. The fracture had occurred about 8 inches from the inside of the fixed bearings, and the shaft had become loose in the roller. There being no new shaft obtainable in less time than a week, and a large quantity of sugar-cane already cut which would spoil in that time, the writer proposed to cut off the inside and broken ends of the shaft close up to the bearing of the roller, and by putting new keys to thus use the two useful ends of the shaft as gudgeons instead of as a continuous and solid shaft; but the resident engineer and one from a neighboring plantation insisted that such a plan was impracticable, inasmuch as all experience had taught them that a shaft which had once broken was sure to break again, and was not safe for a day even. So strenuously was this insisted upon that the proprietor of the plantation (Pln. "Spring Garden") decided to act upon a suggestion to have a temporary shaft of Hackia or iron-wood fitted to the roller (an expedient which had been before resorted to), and to dispatch a small trading sloop to Georgetown, Demerara, to obtain a new shaft.

Upon taking the broken shaft out from the roller, the writer found the surfaces of the fractured ends to be studded with somewhat coarse and well-defined crystals, and remembering the chain-link experience, undertook to put in the shaft ends, upon the condition that the job was only to be paid for upon its proving successful; the wooden shaft, however, was first tried, and it lasted two days, whereupon the writer annealed the shaft ends over a wood fire, allowed the iron to cool off in the embers, deepened the key-seats and keyed the shaft ends to their places, where they remained in successful operation when the writer left in 1860

Similar experiences have doubtless fallen under the observation of many observant practical mechanics, though but little has been written upon the subject. The experience of the writer has led him to the following conclusions:

That crystallization will rapidly take place when wrought-iron is repeatedly heated without being well worked at each heat. Thus, apprentice blacksmiths will sometimes find a forging, which their want of skill in manipulating has caused them to heat and reheat without working the iron much, will jar off and break in pieces upon the anvil or upon using. Especially is this the case when the iron is of inferior quality, though it will occur with either low moor or Swedish iron. It would appear that unless the metal is so worked as to keep the fibre continuously moving, it loses its fibrous texture, and assumes a granular or crystallized texture, and to this fact is doubtless due the impracticability of forging very heavy solid wrought-iron ordnance.

Crystallization will rapidly ensue when wrought-iron is subject to blows delivered endwise of the grain; thus if a piece of cold bar-iron be stood up and struck repeated blows endwise of the grain, it will afterwards be found to break across the grain very easily; and, again, when a shaft has had to be cut shorter in the lathe so that there will be left a piece in the centre of, say, an inch in length and an inch in diameter, the machinist will find the iron offer the usual resistance to being cut off with the chipping-chisel, if cut across the grain; but if he nicks it around close up to the body of the shaft, and then strikes the end of the projecting piece sharp blows with a comparatively light hammer, it will usually break short off in the neck. A noticeable feature in this latter instance, however, is that if the blows are delivered with a hammer sufficiently heavy, and the blows are sufficiently heavy to upset or rivet the metal of the projecting piece, it will usually rivet or burr outward and flatten outward without breaking off, but will split in all directions, each separate piece retaining its fibrous texture, and evidencing no tendency to crystallization, especially if the iron is of good quality, for crystallization takes place much more rapidly in inferior than in the better qualities of iron.

Another instance of crystallization through successive blows, especially those of a jarring nature, is to be found in the frequency with which the heads or the junction of the end of the thread and the body of the bolt beneath the nut, with which bolts upon trip or steam hammers will break. It may also be observed, that crystallization, by reason of sudden and repeated shocks to the metal, is greatly accelerated when the latter is at the same time subject to abrasion upon its exposed surface, as in the case of chain-links, which, from constant rubbing one against the other, will become almost bright, and the outer skin slightly hardened.

Rapid crystallization takes place when a piece of wrought-iron is subject to a degree of heat above that of the normal temperature of the atmosphere, although crystallization from this cause appears to be considerably retarded when rapid oxidization or corrosion on the surface of the metal takes place. The writer is also led to believe that crystallization from all these causes is considerably retarded when the shaft or bolt is a hollow and not a solid one.

Crystallization, from all these causes, save that of repeated heating without sufficiently working the metal by the blacksmith, appears to be entirely removed by the process of annealing, which is best performed by either a charcoal or a wood fire, the metal being allowed to cool in the ashes, and not made in the process of more than a blood-red heat.

A piece of iron that has been crystallized by repeated heating, and not being sufficiently worked by the blacksmith, so that it has what is commonly called "lost its virtue," may be recovered by heating it to nearly a white heat, and well working it with the hammer upon the anvil, especially if well drawn out in the direction lengthwise with the grain of the iron.

Steel of even the commonest grade does not appear to suffer from crystallization, except it be that due to overheating or successive heating without forging. Thus if a chipping-chisel after long service be broken in two, no evidence of crystallization will appear. Nor does decarbonized steel, or what is sometimes termed homogeneous iron, appear to crystallize under any conditions save under the above exception. If, however, the best cast-steel is once overheated, no ordinary amount of forging will restore it, as is evidenced by the fact that a turning tool once overheated, no matter how much it may subsequently be forged, will not perform a maximum of lathe duty.

THE American Brewers' Association has decided to construct a large edifice at the Centennial. The structure will be star-shaped, and in one section will be exhibited the brewery of fifty years ago, when beer-making was done by hand. Another section will show the improved brewery of the present day. All the accessories to the business will be represented, from barley in the sheaf, growing hop-vines, etc., to the finished beverage.

PROCEEDINGS OF SOCIETIES.

AMERICAN SOCIAL SCIENCE ASSOCIATION.

THE American Social Science Association held its eleventh annual meeting at the Lowell Institute Hall, Boston, January 12th. In reference to the overcrowding of houses, which is said to be greatly on the increase, it is said that the census returns of 1875 show that in Boston there are 320,000 inhabitants and 40,817 occupied dwellings, at the rate, that is, of 8.4 persons to each dwelling, while in the old wards the rate is as high as 12.2 and 11.7. In Fall River there are 45,340 inhabitants and only 4192 occupied dwellings—10.8 persons to each house. In Holyoke, 16,260 inhabitants and only 1462 occupied dwellings—11 persons to each house. The town of Adams, in Berkshire county, has 8 persons to each house; the city of Lawrence 8.3 persons, the city of Worcester 8.2 persons. In all, or nearly all, these places the ratio has risen since 1870. In Providence there are 100,675 inhabitants and 12,954 occupied dwellings, or 7.76 persons to each. In Brooklyn and in New-York City there is somewhat more than the extreme overcrowding noticed in 1870. The contrast between the two largest American cities—New-York and Philadelphia—in this respect is very marked, and in the highest degree unfavorable to New-York, where also the condition of things is growing worse, while in Philadelphia it is growing better. By the census of 1870 the number of dwellings in New-York was about 64,044, for a population of nearly a million—an average, therefore, of nearly 15 persons to each dwelling. But in 9 of the 22 wards of New-York a population of 365,000 was housed in only 17,110 dwellings—an average of 21 1-3 persons to each dwelling.

When Paris (in 1835) contained about the same population that New-York now numbers, the number of houses there was 50,476, and the number of persons to each dwelling was 23, or just about the same overcrowding that we find in the worst parts of New-York.

In Philadelphia, on the other hand, a population of 674,000 in 1870 was housed in 112,366 dwellings, giving 1 house to every 6 persons, while, in the worst wards of Philadelphia the average number of persons to a dwelling did not much exceed 8, or only a third part of the New-York average, which, in one ward of nearly 100,000 inhabitants, was more than 24 persons to each dwelling.

The number of dwelling-houses built in Philadelphia since 1870 is about 24,000 (at the rate of a little less than 5000 a year), so that the present number of dwellings in that city is upwards of 135,000, which, at an average of 6 persons to each dwelling, would give a population in 1875 of 810,000. This is more than the estimated population of the city, and therefore the proportion of dwellings to population has been increasing there—the very result we should expect from the system of building pursued in Philadelphia, and the very opposite of what is taking place in New-York. In other cities the contrast is not so striking. In Boston, for example in consequence of successive annexations of suburban territory, the proportion of persons to each dwelling in the whole city has considerably diminished in thirty years, and does not now much exceed eight persons to each dwelling.

In certain wards of Boston, however, the proportion is about double this, and there are 100,000 of the present population of Boston housed at the rate of twelve persons to each dwelling. Thirty years ago, when the whole population was a little above 100,000, the number of occupied dwellings was 10,300, giving an average of nearly 10 persons to each. In 1865, twenty years later, but before the annexations, a population of 193,318 was housed in 20,649 dwellings, or at the rate of nine and one third persons to each. In 1870 the population had increased (chiefly by annexation) to 250,520, and the dwellings to 29,623, giving one dwelling to every eight and one half persons.

According to the census of 1870, there were in Brooklyn, N. Y., 396,099 inhabitants and 45,834 dwellings—one for every 8 2-3 persons; in St. Louis, 310,864 inhabitants and 39,675 dwellings—one for every 7 4-5 persons; in Chicago, 298,977 inhabitants and 44,620 dwellings—one for 6 2-3 persons; in Baltimore, 267,354 inhabitants and 40,350 dwellings—one for 6 2-3 persons; in Cincinnati, 216,239 inhabitants and 24,550 dwellings—one for 8 4-5 persons; in New-Orleans, 191,418 inhabitants and 33,656 dwellings—one for 5 2-3 persons; in San Francisco, 149,473 inhabitants and 25,905 dwellings—one for 5 3-4 persons; in Washington, 109,189 inhabitants and 19,545 dwellings—one for 5 3-5 persons; in Newark, N. J., 105,059 inhabitants and 14,350 dwellings—one for 6 5-8 persons; in Jersey City, a suburb of New-York, 82,546 inhabitants and 9867 dwellings—one for 8 1-3 persons.

Taking together the three cities of New-York, Brooklyn and Jersey City, there was an aggregate population of about 1,421,000 in 1870 living in less than 120,000 dwellings (one for twelve persons). At the present time it is probable that these three cities contain more than 1,700,000 inhabitants, occupying no more dwellings than are found in the single city of Philadelphia, with less than half as many inhabitants.

The results of this overcrowding of a city population are perfectly well known and are painfully obvious in New-York and its suburbs. The city proper, built along the narrow island of Manhattan, s thus crowded between two rivers, and the value of the land for commercial uses has so raised its price that in all the lower portions of the city the dwelling-houses can only be owned by the rich, with rare exceptions. For the same reason they are built of many stories and crowded together without sufficient provision for light and air. In many locations old buildings, once good but now almost unfit for habitation, have been crowded full of poor families, who pay an expensive rent for wretched tenements.

The paper then went into an elaborate description of the various benefit building societies of Philadelphia and Chicago, to show that these were the remedies for overcrowding. In St. Louis, where building societies are largely encouraged, the death rate is lower than in any large city in the world except those on the Pacific coast. At one time this city was at the other end of the list.

The tenement-house population of New-York and Brooklyn probably exceeds 250,000. In Boston there are now 2700 tenement-houses, containing 43,000 rooms and inhabited by more than 60,000 people. A portion of these are new and well built, even costly houses, but nearly 50,000 of this tenement-house population in Boston are living in discomfort from overcrowding, many of them in houses quite unfit to be occupied. The death rate is found in Boston, as in New-York, to be largest in these districts where there are most tenement-houses, and there, also, crime and vice and prostitution most abound.

It appears that overcrowding already prevails in a few American cities, notably in New-York and its suburbs, in Boston and in Cincinnati, but that in most of our cities there are more dwellings in proportion to the number of inhabitants than in the cities of Europe. The tendency here is for overcrowding to grow worse from year to year, as our city population rapidly gains; but this tendency is counteracted in many cities by the inclusion of cheaper land within the city limits by the increased prosperity of the working people (who have been quite steadily improving their condition since the beginning of the civil war) and by the action of municipal governments and benevolent citizens. In Philadelphia and a few other cities a great check has been given to overcrowding by the action of the benefit building societies, which, contrary to the general custom of those societies in England, do provide homes of their own for working people even of the humblest grade.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND, DECEMBER.—A paper was read by Mr. D. J. Dunlop, of Port-Glasgow, on "A Pneumatic Governor for Marine Engines." The Dunlop governor anticipates all accelerations of the engine-speed, and the evil to be guarded against does not need to take place in order to call the apparatus into action, inasmuch as for every foot of the propeller's diameter which emerges from the water, the steam-valve is closed proportionately, and the valve may be so set as to close when any proportion of the diameter is out of the water. This governor is now applied to about sixty screw-steamers, including two vessels with engines of 600 horse-power each, in the Pacific Steam Navigation Co.'s line.

WEAR OF WIRE ROPE.

THE directors of the Clay-street Hill Railroad, San Francisco, recently removed the old wire rope which has been in use for some two years, and substituted a new one. The road runs up Clay-street Hill, and the cars are propelled by an endless wire rope passing up one side of the street and down the other, underground. The engine furnishing the power is at the upper end of the line. The old rope was 7000 feet long, three inches in circumference, and made of 114 steel wires, of No. 16 gauge. It was put in use August, 1873. It was made to work seventeen hours a day while running. During this time, it carried 3,300,000 passengers.

A few deductions, showing the work obtained from this rope will be of interest. The 3,300,000 people, at an average of 150 pounds apiece, would give 495,000,000 pounds. Eight cars go up twenty-five times a day for 840 days, giving 705,600,000 pounds. Adding the weight of the cars to passengers, it gives 1,200,600,000 pounds, or 600,300 tons, raised 307 feet vertically in a distance of 3300 feet in 840 days, working seventeen hours a day. The result is, we get 1,200,600,000 pounds raised 307 feet in 853,800 minutes. This rope travelled 64,260 miles, or more than equal to two and a half times the distance around the globe.

While this rope was running, it stretched about one per cent, or 70 feet on the 7000. It was reduced in circumference about seven thirty-seconds of an inch. The consumption of coal by the engine to perform this work was about 1500 pounds of Wellington screenings per day, at $9 per ton. From experiments made at the station it was found that it took six pounds of steam to keep the rope running (unloaded) after it was started. It took twelve pounds to overcome the inertia and friction. The cylinder of the engine is twelve by twenty-four inches. The rope was made by A. S. Hallidie, of San Francisco, from imported steel wire. The changing of the ropes took thirteen hours. The rope shows little signs of wear, and would probably last a year or more longer with safety; but the directors thought best to take all precautions, and change in time.

The new rope is 7000 feet long, and weighs 10,800 pounds. It is made of fine steel wire, hardened and tempered, No. 16 gauge. There are 114 steel wires and nineteen soft iron wires for the heart. The rope is three inches in circumference, and was made at Hallidie's factory, in this city.

As a matter of record, we may also mention the data obtained for a rope in use at the Crown Point Mine on the Comstock. Mr. Hallidie has a statement up to the 6th of November. The steel rope was set at work August 1st, 1874, on the incline. The rope is 2650 feet long, 6¼ inches in circumference, and weighs 17,237 pounds. Up to the data mentioned, it had worked 10,928 hours, and hoisted 209,592 tons. It runs at a speed of 670 feet per minute. Total weight of each lift, 34,000 pounds; vertical distance, 1500 feet in 10,928 hours. The rope is still at work and in good order. The record of these ropes speaks well for California manufacturers.—*Scientific Press.*

HYDRAULIC LOCOMOTIVE.

ITS origin is traceable to the introduction of flumes for floating lumber from the mountains to the valley. While the flume was and is the cheapest transportation known for the purpose for which it was designed, the transportation of lumber, it served no other purpose. All the supplies demanded at the head of the flume, where the lumber was manufactured, had to be hauled there by teams. These flumes did nothing but transport lumber to the market. They transported nothing into the mountains; afforded no aid to travel. The flume lay along the mountain sides like a serpent basking lazily in the summer sun. The hydraulic locomotive is designed to make them serviceable in more ways than the one for which they were originally built. It is designed to travel up the flume, and it does it, too, at a lively rate. The steeper the grade the faster travels the locomotive. This may be in defiance of all former means for the transportation of freight and passengers, but the locomotive will do it nevertheless. The little wooden structure we saw on trial carried ten or twelve times its weight, and moved up a grade of about one foot to the rod at about half the speed that the current an inch in depth ran down the grade. Now, what the result will be when it is tried on a scale to be made serviceable for transportation of freight and passengers, of course we are unable to say; but as a toy it is successful, for the little machine, weighing only a pound and a half or two pounds, carried ten or twelve times its own weight. The hydraulic locomotive is constructed with four wheels, and is designed to run on a track like the locomotive-engine. The track is to be constructed on the top of the sides of the flume, which may be V-shaped or otherwise. The motive power is the water passing through the flume. At either end of the car is a water-wheel similar to that of stern-wheel steamers. The wheels, like those of an ordinary car in use on our railroads, revolve with the axle. The axle, to which the wheels are attached, is made the shaft for the water-wheel, the arms of which holding the paddles extend down into the water in the flume. The current of water in the flume furnishes the power to run the car. Of course the car must travel up the flume if it contains sufficient water to turn the paddle-wheels. These paddle-wheels are so arranged as to be unshipped when it is desired to run down the flume. As all flumes of this character must have a down grade, the hydraulic locomotive is supplied with brakes to regulate the speed on the down trip. We believe the hydraulic

locomotive to be practical. Of course it will require a considerable volume of water to move a car of ten tons. This can be obtained near the head of Butte Creek if it should prove desirable to have a flume to the timber of that region, and any volume of water necessary for and down Feather River could be had at the lower end of the Big Meadows. Of course the flume would have to be constructed with a view of having the track for the car on the top of its sides, and braced from the outside, so that no ties or cross-pieces would be required on the top of the flume, as that must be left open for the paddle-wheels to work in. If it should cost as much to build a flume of this kind as it does to lay a railroad-track, the advantages would still be in favor of the flume, for the economy of motive power is much greater. Indeed, it is nothing at all after the track and flue have been constructed. It would also have the advantage of being narrow gauge, which is an important consideration through a mountain country.—*Butte Record.*

ON THE USE OF TIN AND GOLD COMBINED.

By J. PAETSCH, M.D., D.D.S., Berlin, Prussia.

I HAVE frequently seen good operators make gold fillings for very delicate patients, who were compelled to suffer for hours. I am sure that the same could have been made in much less time, and the teeth have been preserved quite as well—perhaps better—by using tin and gold. I say "perhaps better," because such a tooth requires, for a gold filling, so much time and so much pressure, that besides the other disadvantages, inflammation may follow. It is not the first requisite that we should make as fine a piece of workmanship as the goldsmith. Our first task is to preserve the tooth, at the expense of as little pain and discomfort to the patient as possible. If, besides this, we can superadd fine workmanship (as we, fortunately, can do in most cases), so much the better.

In operating with tin and gold (and I beg you to note, gentlemen, that during the six years I have used these materials combined not one of my patients has ever experienced the slightest pain or trouble from galvanic action), I have found them a much poorer conductor of heat than gold alone. In the winter season, when my patients have complained of an uneasy feeling in those teeth that had been filled with gold, they have *not* complained of those in which the combined metals had been used, although the latter were more involved in decay. It was the observation of this fact that led me to put a stratum of tin and gold in the bottom of very deep cavities, where the caries has approached very near the pulp-cavity; then build the gold on this as a base. An excellent filling is the result, and the patient does not complain of pain attendant upon changes of temperature in the mouth. In addition, there is this great advantage: such a filling can be made in half the time that the gold alone would require.

A NEW METHOD OF IMPARTING ARTISTIC FINISH TO PHOTOGRAPHS.

By E. DUNMORE.

THE materials are few and their application easy; they consist of sandpaper, of various degrees of fineness, cardboard, and glue—that is all. Use them after this fashion: Cut a piece of cardboard somewhat larger than the mounted proof, upon which glue sandpaper, face up; and when dry, cut out an aperture corresponding exactly in shape and size with the picture to be operated upon; make the edges of the aperture smooth and even. This constitutes the mask or die. Suppose it is a medallion portrait of the usual *carte* size you wish to finish: fit the sandpaper mask, face down, on the enamelled side of the portrait, adjusting it so that the oval picture corresponds with the aperture of the mask. Place a piece of smooth paper outside for the purpose of printing, scratch on the polished parts, and pass the whole through an ordinary rolling-press, face down. On removal, it will be found roughened on those parts that have been in contact with the sandpaper, and the polish and relief of the smooth portions greatly enhanced by the contact. Various degrees of fineness may be obtained by slightly shifting the position of the mask, and putting through the press after each alteration. This is the novelty. Other substances besides sandpaper can be used. Probably an engraved metal plate would be better; in fact, almost any textile fabric, such as net, gauze, lace, etc., is applicable. For my own part, I prefer the effect of sandpaper to a more ornamental design, a flat mat surface being as good as any thing, if not better, for giving value to the polished part.

CONDENSED BEER.

MR. LOCKWOOD describes, in the *Journal of the Society of Arts*, his patent solid or condensed beer. Beer is taken at its best condition, its alcohol is separated and saved by a method of gentle distillation *in vacuo*, and the residue is condensed in a vacuum-pan, like milk. When finished, it is inclosed in hermetically-sealed packages, the alcohol first being added to it again, and acting as a preservative. The fermentation which was present in the beer when it was taken is suspended by the heating, and the condensed beer remains sound in this condition, apparently for any length of time, as some exists that has now been kept for nearly two years. When re-made by adding water, it is not wort, but real beer, having all its flavor and alcoholic strength, and lacking only effervescence, which can be quickly imparted by reviving the suspended fermentation for a short time in order to develop sufficient carbonic acid gas to give it the required briskness; or it is fit to drink immediately, if charged with carbonic acid gas, like aërated water.

AMERICAN CHAPEL, ROME.

THE new American chapel, dedicated to St. Paul, is in course of erection in Rome, from the designs of Mr. G. E. Street. The church consists of nave and aisles, of five bays and a semi-circular apse. The walls are constructed of brick and stone in alternate courses, stone from Arles being employed for the interior, and travertine for the exterior work. The nave arcade is carried on columns of red granite with gray marble shafts. The building, which is now roofed in, is covered with tiles, and the aisles are groined in brick with stone ribs, and the apse has a semi-dome in brick. The tower, which will be crowned with a low spire, will measure forty-three metres from the ground to the top of the cross on the summit. The building is lighted by two light windows in the aisles, and single lights in the clerestory, and a large rose window at the west end.—*The Architect.*

USE OF PAPER.

OF the 1,300,000,000 of human beings inhabiting the globe, 370,000,000 have no paper nor writing material of any kind; 500,000,000 of the Mongolian race use a paper made from the stalks and leaves of plants; 10,000,000 use for graphic purposes tablets of wood; 130,000,000—the Persians, Hindoos, Armenians, and Syrians—have paper made from cotton, while the remaining 30,000,000 use the ordinary staple. The annual consumption by this latter number is estimated at 1,800,000,000 pounds, an average of six pounds to the person, which has increased from two and a half pounds during the last fifty years. To produce this amount of paper, 200,000,000 pounds of woollen rags, 800,000,000 pounds of cotton rags, besides great quantities of linen rags, straw, wood, and other materials, are yearly consumed. The paper is manufactured in 3900 mills, employing 90,000 male and 180,000 female laborers. The proportionate amounts manufactured of the different kinds of paper are stated to be—of writing paper, 300,000,000 pounds; of printing paper, 900,000,000 pounds; of wall paper, 400,000,000 pounds; and 200,000,000 pounds of cartoons, blotting paper, etc.

[Baltimore American, January 10.]

WRECK OF THE BALTIMORE AIR-SHIP.

THE Schroeder air-ship, which has been lying in a nearly completed state just beyond Boundary avenue, on the northwestern suburbs, was almost totally destroyed last Thursday night by the heavy gale which prevailed. The board fencing surrounding it had been removed to one of the neighboring yards, and preparations were in progress for stowing away the ship until next spring, when the company who owns it expected to raise sufficient means to arrange for a trial of the invention. On Thursday night the ship was left exposed upon the broad common, and when the wind came it twisted the big machine into a shapeless mass of irregular wickerwork and broken boards. The force of the gale must have been great, for the strong iron frame is contorted and strained, and where the ship was secured in the ground the earth has been torn up for several feet around. The machine is so seriously damaged and strained that it is not likely that its use will be either possible or safe. The wreck was yesterday viewed by many persons who were attracted to the place by the odd-looking thing as seen from a distance.

[Medical and Surgical Reporter.]

THE QUESTIONABLE VALUE OF HYPODERMIC SOLUTIONS.

DR. LAFITTE, of Paris, attacks hypodermic medication, so far as the alkaloids are concerned. He says, not the alkaloid, but simply the water, distilled or not, has the merit of allaying pain. Startling cases are mentioned (*L'Union Méd.*, Nos. 113 and 114, 1875), and from these we find that severe lumbago, obstinate neuralgia, etc., are instantly relieved by the injection of about thirty drops of water. Failures are but few, and the author consoles himself respecting these by the consciousness of not having done any harm, if he did no good.

M. Lafitte now asks himself how the simple water acts, and he throws out the theory that the ultimate nerve filaments are compressed by the water, and, being thus paralyzed, can no longer convey the sensation of pain. M. Lafitte goes the length of maintaining that all the hypodermic injections hitherto performed acted through the agency of the water, and he is very particular in stating that his operations were never followed by abscesses or any unpleasant symptoms.

[New-Bedford Evening Standard.]

IRON LIGHTHOUSE.

MR. EDMUND GRINNELL, of this city, is now finishing at his foundry, on South Water street, an iron lighthouse, to be erected by the government on a coral reef at Sand Key, near Key West, Florida. The structure, for the building of which Mr. Grinnell has the entire contract, requires the use of 35 tons of wrought-iron, and 40 tons of cast-iron. It consists of a keeper's dwelling, surmounted by a tower. The dwelling is 38 ft. square, and 12 ft. 6 in. high. It contains 7 rooms, each 12 by 12 ft., besides an oil-room. The tower, which rises from the centre of the building, is 96 ft. high and 8 ft. in diameter. The dwelling is constructed of cast-iron plates, and the tower of wrought-iron, securely bolted together. As the reef on which the lighthouse is to be placed is entirely under water, wrought-iron piles will be driven into the coral, from which columns will rise to secure the tower.

SUNSHINE.

AT a recent meeting of the Meteorological Society, London, Dr. J. Mann, President, in the chair, a paper was read "On the Registration of Sunshine," by R. H. Scott, F.R.S. This paper is on the continuous record of sunshine and rainfall obtained at Kew for September, 1875; the latter by Beckley's rain-gauge, the former by a method originally proposed by Mr. J. F. Campbell, of Islay, F.G.S. This consists in the use of a sphere of glass to concentrate the sun's rays, and a strip of cardboard is placed on a frame concentric with the sphere, and distant from it by its own focal length. The sun when it shines burns a hole in the cardboard, the length of the trace being regulated by the duration of the weather.

ON THE CHEMISTRY OF THE URINE.

GALIPE (*Pharm. Zeitschrift f. Russland*, XIII. 683) uses the following method for the determination of albumen, which is applicable in the presence of the phosphates or the urates. A test-tube is one third filled with a deep yellow solution of picric acid, and one or more drops of the to-be-tested urine added. If albumen is present, there immediately appears a sharply-marked white cloud; upon heating the liquid, the albumen collects in a lump and floats. The reaction leaves nothing to be desired for delicacy.

E. Reichardt, in the same journal, XIV. 45, demonstrates the presence of a body similar to dextrine in albuminous urine.

David writes (*Bull. de la Soc. de Chem. de Paris*, XXIII. 235) of a peculiar urine which decolorizes Fehling's solution, but did not affect the beam of polarized light. A substance possessing the same properties was separated from the urine. The death of the patient so limited the supply of the material that further investigations were prevented. Z. B. E.

THE WOOD OF NOAH'S ARK.

IN the ancient Egyptian temples stones have been found tied together by a kind of dowel of wood on their upper surfaces, and these wooden ties of dove-tail form were inserted about an inch deep. Some of these have been found quite sound in temples known to be at least four thousand years old, thus proving the wood to be of the most durable kind. The ties are said to be the tamarisk or shittim wood of which the ark was constructed, and which was a sacred tree in ancient Egypt, though now very rarely found. The thought occurs why, instead of metal dowels, wooden ones could not sometimes now be used. Though metal ones would last longer they not unfrequently split the stone.

CORNISH PUMPING ENGINES.

THE *Mining Journal* gives reports of sixteen pumping-engines. They consumed 1703 tons of coal, and lifted 12,400,000 tons of water 10 fathoms high. The average duty of the whole is, therefore, 49,200,000 lbs., lifted 1 ft. high, by the consumption of 112 lbs. of coal, being a little over seven tenths of a pound of coal per horse-power.

COAL-MINES IN RUSSIA DEVELOPED BY AMERICAN LOCOMOTIVES.

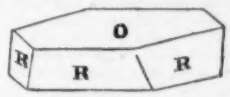
A CONSULAR report from Russia says: "The first ten locomotives were imported to St. Petersburg in 1872 from the Baldwin Locomotive Works of Philadelphia, followed by twenty more from the same firm, and last summer fifty more were contracted for at the Grant Factory, in New Jersey. The great moment of this incipient trade will be apparent from the fact that there is an immense field here open for their import for many generations to come, the railroad lines to Russia having just begun to develop on a greater scale, those in operation hardly reaching to 18,000 English miles up to this day. The smaller locomotives heretofore built in Russia, at the rate of 100 to 120 only a year, also those imported from Germany, France, and Belgium, were all built for consumption of wood for fuel till the agent of the Philadelphia firm had brought the attention of the consuming department to the fact that anthracite coal of best quality can be found around the town of Worenesk, in Southern Russia, extending over 180 miles, and that whole regions were abounding with it in the southern half of the empire, sufficient to feed the locomotives of the whole continent. The American locomotives finally accepted and introduced here, being expressly built for coal consumption only, have led Russian capital to the development of the now quite numerous coal-mines in the district named. On account of the faultless finish of the American locomotives and their superior power, guaranteed to haul on a level 1075 tons, in lieu of those heretofore in use, hauling but 650 to 700 tons, they are much preferred, as the higher price paid for them—namely, 25,000 silver roubles apiece, instead of 18,000 to 20,000 silver roubles paid for those brought in from Germany and Austria, would indicate."

CHALCOPHANITE: A NEW MINERAL SPECIES.

MR. GIDEON E. MOORE, Ph.D., describes in the *American Chemist* a new mineral found at Stirling Hill, Ogdensburg, N. J.

The mineral occurs in druses of handsome and lustrous but minute crystals, and in foliated aggregates lining the walls of the cavities in the matrix, or grouped to stalactitic and plumose forms. The lamellar structure is perpendicular, or nearly so, to the surface upon which the crystals are implanted, or, in the stalactitic forms, to the direction of the latter.

The following figure represents a type of frequent occurrence among the more perfect crystals:



The face O possesses a brilliant lustre, and gives perfect reflections: the rhombohedral faces are far less brilliant, and are often deeply striated parallel to the basal plane.

The crystals are often flattened out to the thinnest scales, and these are in some cases grouped together parallel to O, forming aggregates which often bear a strong resemblance to combinations between a hexagonal prism and the basal plane. The prismatic faces, however, reveal their composite character by the absence of lustre and the frequent striæ parallel to the basal plane.

Cleavage: Basal; perfect. Structure: foliated; micaceous. Thin laminæ, very slightly flexible.

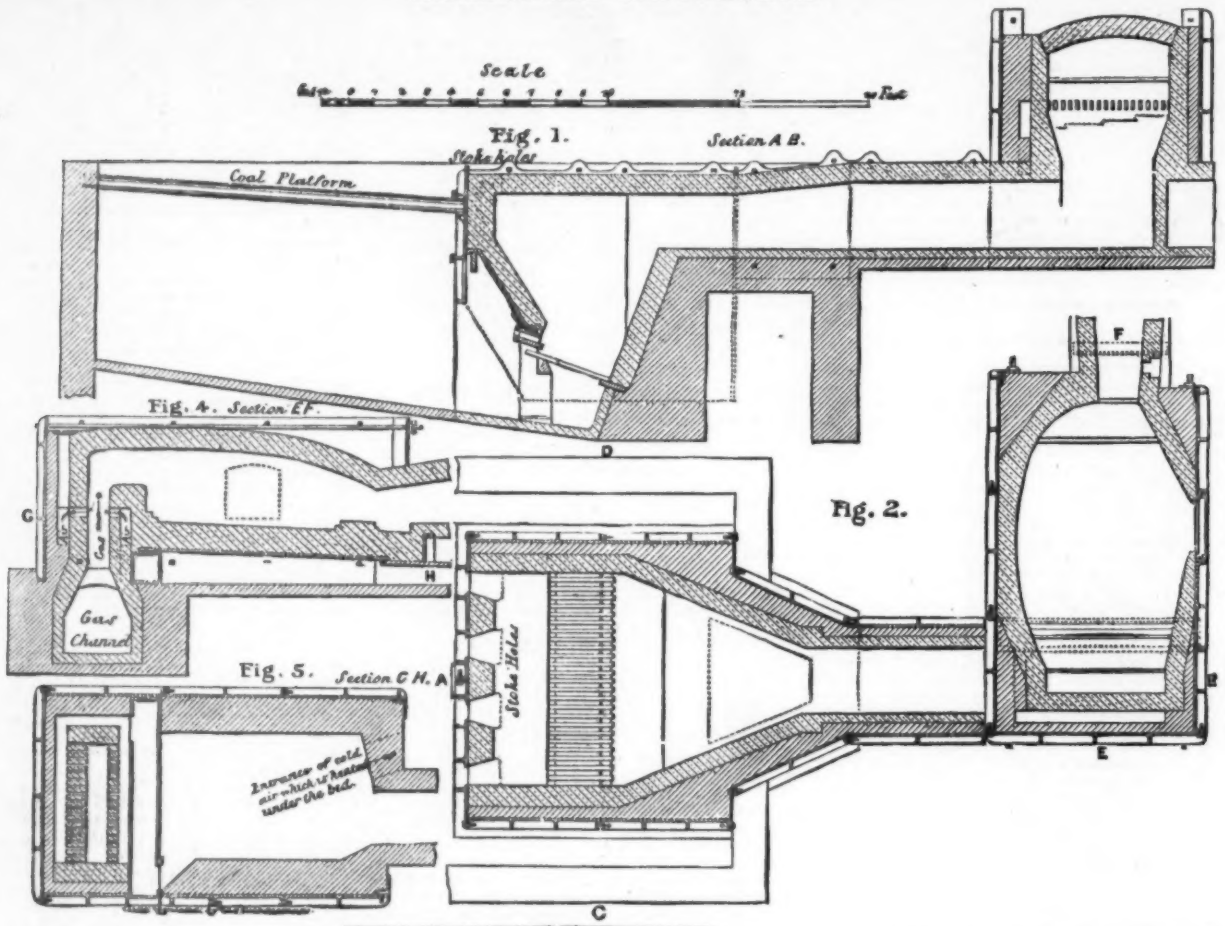
Hardness = 2·5. Cuts with a smooth surface like graphite. Specific gravity = 3·907. Lustre: metallic; splendent on the basal plane, usually dull on the other faces, except in the more perfect crystals. Color, bluish-black, in the larger and more perfect crystals, verging on iron-black. Streak, chocolate-brown, dull. Opaque even in the thinnest lamellæ.

Before the blow-pipe turns of a color varying from pale yellowish bronze to copper-red, exfoliates slightly, and on continued heating darkens in color, and shows traces of fusion on the edges of thin laminæ. In the closed tube gives off water and oxygen, exfoliates slightly, and changes to a mass of loosely coherent laminæ of a golden-bronze color, and metallic lustre, greatly resembling in appearance certain varieties of the mineral enstatite (var. bronzite). With borax, a strong manganese reaction, the button becoming cloudy in the reducing flame. On charcoal, with soda and borax, a coating of oxide of zinc. Soluble in muriatic acid, with evolution of chlorine on warming.

The species is of recent origin, being evidently a product of the decomposition of franklinite and other manganiferous and zinciferous minerals.

THE developments of the Comstock lode in the State of Nevada form a special subject to the Director of the Mint in his report lately submitted to the Secretary of the Treasury. A careful examination of the consolidated Virginia and California mines was made by the Director and Prof. R. E. Rogers in July and August last. The annual product of the Comstock mines is estimated at $50,000,000, about 45 per cent of which will be gold; a product equally large from domestic sources may be anticipated during 1876. Professor Rogers expresses the opinion that the ore in the two mines above mentioned will give an ultimate yield of three hundred millions of dollars.

BICHEROUX'S GAS-FURNACE.



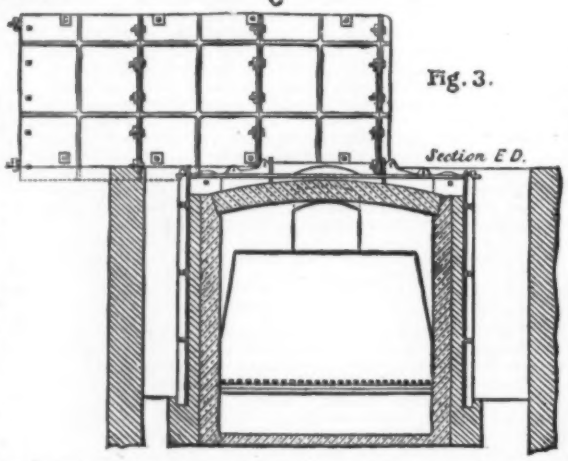
[Engineering.]

BICHEROUX'S GAS-FURNACE.

WE give above engravings showing the construction of Bicheroux's gas-furnace, an arrangement which has been for some time in extensive use on the Continent, especially in Westphalia (for instance at the Rhenish Steel Works Company, in Ruhrort, at Jacobi & Haniel's works in Oberhausen, and at Harkort's works in Duisburg), in Belgium (at Ougrée, Séraing, Angleur), in France (Moncean, Ars-sur-Moselle), and in Austria at the Railway Works at Gratz. More recently Bicheroux's gas-furnace has been introduced into England by Mr. C. Holste, of 21 Great St. Helen's E. C., and the first furnace on this system was started about twelve months ago at the well-known Round Oak Iron Works belonging to the Earl of Dudley. Another furnace was started at the same works about two months ago, and we understand that it has been decided upon to alter all the furnaces to this system. The accompanying views will show at once the principal features of the Bicheroux furnaces. The heating furnace is of the ordinary kind, but where the grate is usually placed, passages are built for the gas and air. The furnace is connected by means of a canal with the producer, the latter being of a very simple construction; it consists of two vertical side walls, and inclined front and back walls. The front slope is supported by a strong framing, the back slope by brickwork. The whole is vaulted over with firebricks. At the bottom of this so-formed chamber are the fire-bars, about 2 ft. 6 in. long; they can easily be taken out to enable the stoker to draw the clinkers from the producer. There are besides two folding-doors for the ash-pit, by means of which the air can be completely shut off, so as to stop the generation of gas. At the top in front are three or four stokeholes, through which the producer is fed; these stokeholes are either closed by bricks or simply by small coal. Before the stokeholes is a platform for the stoker and a supply of coal. The producer may be placed entirely above ground, and then requires the side framing, as shown; or it may be placed under ground, when the side framing may be replaced by brick walls. If the ground permit it, the producer should be placed under ground, as it then does not stand in the way of the workmen. The distance of the producer from the furnace depends on the circumstances in each case; but in order that the gases may not be cooled on their way from the producer to the furnace, it is perhaps advisable to place them not too far apart. However, in cases where the producers have been placed about 70 ft. from the furnaces, the results have been as satisfactory as where they were close together.

The gas-flue is built of firebricks, and may advantageously be placed underground, when the framing may be dispensed with. This flue is sometimes provided with a slide valve of brick or iron, to shut off the gas when required; sometimes the valve is placed in the furnace, a little under the holes for the air; sometimes there is no valve, as in our engraving. The consumption of coal in the generator may, as we have said, be stopped by closing the doors of the ash-pit, and making them air-tight by means of clay.

The furnace itself is, as already stated, the ordinary one, only in place of the firegrate, passages are built for the admission of gas and air. The gas-passage is the continuation of the flue coming from the producer, the gas entering the furnace over the bridge. Before it passes the bridge, however, it is met by a number of air currents at one or both sides. The air passes from the flue at the sides of the gas-passage into the latter through a number of small holes, formed by firebricks, placed a little apart from each other. The air thus admitted is previously heated, which may be done in various ways, either in the producer and gas-flue, or at the bottom, or sides, or crown of the heating furnace. In our engraving it is shown as being done at the bottom of the furnace. The air enters at the end opposite to the entrance of the gas, and travels slowly under the hearth-bottom (thereby keeping it cool and protecting it from rapid destruction) to a box of cast-iron. From thence it enters the air-passages at the sides of the gas-passage. By means of a slide in the box the furnaceman can control the admission of air, and thereby the heat in the furnace, to a nicety. The ignited gas expands over the bridge into the furnace, where it heats the iron. Thence it goes under the boiler into the chimney.



The Bicheroux gas-furnaces share with other gas-furnaces (Siemens, Ponsard, etc.) several advantages over the old furnaces worked with solid fuel. Amongst others the saving in fuel is considerable: at Round Oak, for instance, when working single shifts only, it amounts, we are informed, to 40 per cent. Another great advantage is that inferior coal may be used in the producer, which could not be used in the ordinary firing furnaces, while the combustion being perfect no smoke issues from the chimney, and the control of the admission of air being so complete, the waste of iron is considerably reduced. The inventors, Messrs. Bicheroux, state that at their plate works in Duisburg the waste for double-heated heavy boiler plates amounts to 13 per cent, and in double-heated light ones to 15 per cent. For the same reason the firebricks of the furnace are better preserved, not being cut by the presence of superfluous air. The furnaceman also is enabled to concentrate all his energy on his proper work, the heating of iron, as the stoking is done by ordinary laborers. He can, therefore, heat more iron; at Ougrée, for instance, in furnaces where one class of iron tires only is heated, it has been found that the old firing furnaces heated 10 tons per 12 hours, the Bicheroux gas-furnaces of the same size 14 tons in the same time.

In comparison with some other arrangements of gas-furnaces, the Bicheroux system has the advantage of being simple and easily applied to existing furnaces, while the working of the Bicheroux furnaces does not differ from that of the old firing furnaces; the ordinary furnaceman is therefore able to handle the Bicheroux furnace in his usual way. The waste heat of the furnace in the Siemens and Ponsard systems is used for heating the regenerators; in Bicheroux's system it is used for heating the boilers, which are usually attached to the heating furnaces. The waste heat from the furnace being so regular, the boilers and brickwork are better preserved, not being subjected to variations in the temperature, and the combustion being complete, the flues require no cleaning, or very rarely.

The same system has also been advantageously applied to boilers, to reverberatory furnaces for smelting purposes, to furnaces for heating Bessemer ingots, etc. It has also been applied to puddling-furnaces, but it does not seem with the same success, at all events not at all places. Whilst some manufacturers claim a complete success, others state that the results obtained are not better than at ordinary puddling-furnaces. It is, therefore, not advisable to apply Bicheroux's system to this class of furnace until greater experience has been gained with it.

[Pall Mall Budget.]

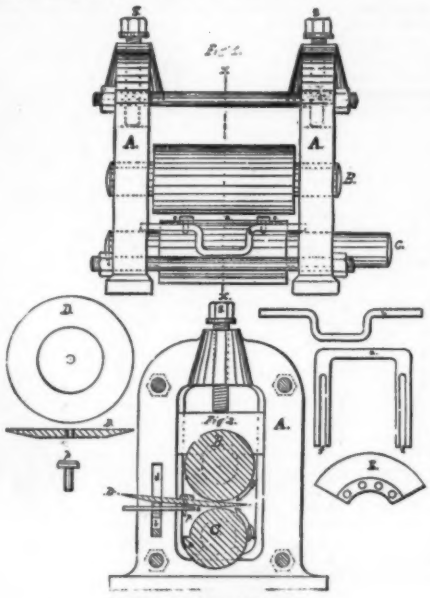
"BRAIN AND INTELLECT."

IN the last number of the *Lancet* there is an interesting paper by Dr. Lawson, Pathologist to the West Riding Lunatic Asylum, on the relation subsisting between the weight of the brain and the extent of the intellectual powers of human beings. It appears, from the investigations of the writer and his colleagues, that not only persons of great mental capacity, but also lunatics, occasionally possess brains which are considerably heavier than the average brains possessed by ordinary but sane people. The average weight of the brain, according to Dr. Lawson, is commonly accepted to be forty-nine oz. in men, and forty-four oz. in women. If we remember rightly, it is placed about an ounce higher for either sex by some other authorities. But the point is unimportant as regards the conclusions at which Dr. Lawson has arrived. Some of the heaviest brains, the weight of which has been accurately ascertained, were those of Cuvier, 64 oz.; Abercrombie, 63 oz.; Goodsir, 57.5 oz.; Sir J. Simpson, 54 oz.; Daniel Webster, 53.5 oz.; and Dr. Chalmers, 53 oz. Against these six names of more or less distinction, Dr. Lawson gives the weights of the brains of six lunatics who died at the West Riding Lunatic Asylum. They were 58 oz. in two cases, 58.5 oz., 59.5 oz., 60.5 oz., and 61 oz. None of these equal in weight the brains of either Cuvier or Abercrombie. But Dr. Lawson observes that perhaps, if all the elements of the case were to be considered, the heaviest adult brain on record might be found to be that of a senile dement who died in the West Riding Asylum at the age of seventy. His brain was found to weigh 61 oz. Following the generally-accepted principle that the brain loses weight to the extent of an ounce in each decennial period, this man's brain, after allowance has been made for physiological diminution, may be presumed to have weighed, when he was at the age of forty, no fewer than 64 oz. But in this case pathological supplemented physiological changes, and the more rapid atrophy which accompanies senile dementia justifies the conclusion that at the time of his maturity this man's brain may have outweighed that of Cuvier. Moreover, out of 705 patients who have died in the West Riding Lunatic Asylum, the weight of brain was found to be in all cases little if any thing below the average as stated by Dr. Lawson. Among rather more than 300 insane women at the same establishment, brains were found weighing from 50 to 56 oz., which, in proportion, were equal to male brains of 55, 58, 60, and 61 oz. Relatively speaking, says Dr. Lawson, these insane women had more brains than Chalmers, Webster, Simpson, Goodsir, and many others adduced as illustrations of the statement that great size of brain usually accompanies great intellectual capacity. Similarly with regard to criminal lunatics; though the average weight of brain among a single dozen of these, examined by Dr. Orange, of Broadmoor, is an ounce and a half under the general male average, there are in that limited number two brains which exceed that of Chalmers in weight, and one which outweighs those of Chalmers, Daniel Webster, and Sir J. Simpson, and is within half an ounce of being equal to that of Goodsir. Small-headed people may take comfort from these statistics. But assuming equal quality, superior quantity of brain would, as it is natural to assume on grounds of physiological analogy, unmistakably tell in the result.

IMPROVEMENT IN ROLLING MILLS.

By J. JEPSON, Philadelphia, Pa.

THE object of this invention is to roll circular plates with a bevel on one side, gradually decreasing the thickness from a centre circle to the edge such plates being used in the manufacture of shingle and veneering saws, which, previous to my invention, were rolled of one thickness to the edge, and the metal ground away to form the bevel, which is a waste of metal, an expense, and loss of time.



IMPROVED ROLLING MILL.

Fig. 1, front view of a pair of housings and rolls. Fig. 2, sectional side view of the same on the line *x x*.

A, housings, constructed as usual. The bearings for the top roll B are supported by springs, or they may be supported by a weighted lever, as is frequently used. The roll B is made of a true circle. The roll C is in the form of an eccentric or cam, as is shown in Fig. 2. *b* is a rest which is fixed in a slot, *d*, in the housings A. To this rest is fixed, by two screw bolts, *e e*, Fig. 1, the stop-gauge *a*, which is adjustable by means of the slots, *f f*. D represents a circular plate or disk with a bevelled edge, as is required for a shingle-saw. In the centre of the plate D is a hole, into which fits a loose pin, *p*. E represents a segment plate, such as is used to make veneering-saws. This segment has a number of holes, into which the pin *p* will fit.

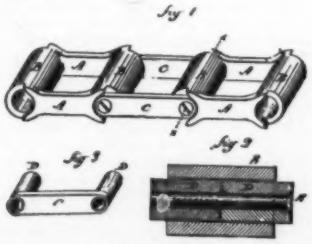
The plates and segments have previously been rolled to their proper thickness for the centre of the saw. A hole is drilled or punched in the centre for the pin *p*, and, in case of a segment, it is cut to the proper shape, and the number of holes desired are drilled or punched for the pin or pins. The plate is then heated to a red heat, the operator grasps it with a pair of tongs, and rests it on the heads of the screw-bolts *e e* and guide *a*, when the pin *p* is dropped in the centre hole, and the plate is pushed between the rolls till the pin *p* is stopped by the guide *a*. Power being applied to the roller C, it revolves in the direction of the arrow, and the edge of the plate being pressed between the two rollers it will be forced towards the operator, and the plate will be drawn down gradually to the edge, it being turned around by the operator, presenting a different part of the plate for each operation, gradually feeding the rolls closer together by means of the screws *s s*, and the plates will be rolled or drawn to the form, as is shown in the drawings.

It will be noticed that the bevel is all on one side of the plate, which bevel is formed by the bottom roll. The length of this bevel may be varied by the form of bottom roll, and adjustment of the stop-guide *a*.

IMPROVEMENT IN CHAIN-BELTS.

By H. BUSHNELL, New-Haven, Conn.

CONSISTS in constructing one link with tubular transverse bars; the next link, or sides of the link, with studs, to enter the said tubular bars.



IMPROVED CHAIN-BELTS.

A, sides of the principal links connected by tubular bars B, the sides and the bars being cast in one piece; C the sides of intermediate or connecting links, each constructed with a stud, D, at each end, as seen in Fig. 3, to enter the tubular bar, the studs being about one half of the length of the tubular bar, and the sides C preferably in line with the sides A, by making an offset on the end of the tubular bars, as seen in Fig. 1. The bars C are preferably secured together by passing a screw or bolt, E, through one to the other, as seen in Fig. 2, the side C and studs formed in one and the same piece of casting. By this construction the bars B are of convenient form for engaging with the teeth of the wheel, and the connections formed between the principal links by means of the studs D, formed on the sides C, are very much stronger than can be made by simply connecting the opposite sides C by a bolt through the bars without the studs, as in this case no strain whatever is brought upon the bolt—it simply secures them in position; and the chain is of very cheap construction, there being but little mechanical labor required in connecting the parts.

IMPROVEMENT IN SPEED-INDICATORS.

By M. A. WIER, London, Eng.

THE invention has for its object the production of an apparatus which shall indicate, and if needful record, automatically, the speed or number of revolutions in a given time, of prime movers, machinery, and other moving objects, in such manner that the said speed or number of revolutions can be ascertained by simple inspection, and without counting or reference to a time-piece.

Fig. 1, front elevation. Fig. 2, back elevation.

A is a cylindrical vessel containing glycerine and water. B, fan or screw, capable of sliding on the axis C, but constrained to turn therewith by a feather. Motion is imparted to the screw B from the revolving object, the speed of which it is desired to ascertain, by a band passing over pulley D on the axis E, which drives the axis C through the mitre-wheels F. G is a double collar on the fan or screw; H, a lever, centred at I, and having a forked end, which takes between the flanges of collar G. A link, H^1, connects lever H to a lever, H^2, which has fixed to it the sectoral toothed rack J, gearing with the pinion K on the axis of the pointer L, arranged to move over the graduated dial-face M. The levers H H^2 and fan or screw B are held, when the latter is at rest, in a normal position, by the springs N O, the pointer L then standing at zero on the scale of the dial-plate. It will now be understood that, rotary motion being imparted to the fan or screw B in one direction, the resistance of the liquid to the motion of the oblique blades thereof will cause it to rise in

Fig. 1.

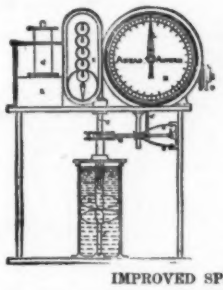
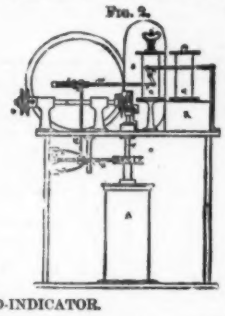


Fig. 2.



IMPROVED SPEED-INDICATOR.

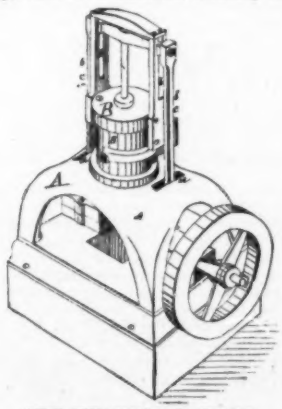
the vessel A, and, by the double collar G, to raise levers H H^2 and sectoral rack J, turning the pointer in one direction, and to an extent proportionate to the speed of rotation of the screw, and consequently of the object by which it is driven. If the driving object is made to revolve in the opposite direction, the screw and levers are depressed, and the pointer L also turned in the opposite direction, the scale on the dial being suitably graduated, and marked in both directions from the zero-point, the number of revolutions in a given time may be ascertained by simple inspection, as also the direction in which the object may be rotating. The springs N and O tend to return the screw towards its normal position, and consequently the pointer toward zero, whenever any diminution of the speed takes place. When it is desired to register graphically the times, speeds, and changes of direction of motion, the lever H^2 is extended, as at P, and made to carry a pencil at its end, or, preferably, in the link of a parallel motion, as shown at P'. The pencil traces a line on a sheet of suitably ruled paper wound on the bobbins Q Q', a uniform motion being imparted to the paper by clock-work contained in the case R, in the well-known manner. When the screw is stationary, the pencil traces a straight centre line on the paper. When the screw is set in motion, the pencil traces a line more or less above or below the centre line, according to the speed and direction of rotation, fluctuations of speed being shown by a zigzag line, the distances of which from the centre line, being measured on a suitable scale, indicate the various speeds, while the distance along the centre line indicates the time.

When the screw revolves in air instead of a liquid, a similar arrangement of apparatus may be employed; but the fan or screw then requires to be made larger, and to be driven at a higher speed.

NEW STEAM-ENGINE FRAME.

By W. S. FINNEY, Harrisburg, Pa.

A REPRESENTS the engine-frame, constructed of one piece of casting, forming a quadruple arch. The juncture of the four arches at the corners provide supporting columns of great stability, with but a moderate consumption of material.



NEW STEAM-ENGINE FRAME.

The crowns of the several arches, uniting, produce a continuous shell, spheroidal in form. The apex is flattened to form a base, upon which is mounted the cylinder of the engine, B. This is of ordinary construction.

IMPROVEMENT IN PROPELLING CANAL-BOATS.

By A. BUGBEE, South-Bend, Ind.

RELATES to that class of vessels which are propelled by streams or jets of water discharged from the stern of the vessel into the body of the water in which it is floating.

First, a pair of turbines is fastened to a vertical shaft some distance apart, with their curved buckets in reversed positions, and operating in a chamber in the stern of the vessel. Thus arranged, the upper turbine will take in the water above, and the lower one below, and both discharge it into the space between them, from which it issues with a force proportional to the velocity with which the turbines are rotated, the downward pressure of one wheel being compensated by the upward pressure of the other, so that the shaft or spindle supporting them will not be subjected to undue wear. Second, racks upon the sides of the vessel, through the openings in which the water is drawn in by the turbines, said openings being divided by oblique plates to aid in propelling the vessel.

Fig. 1, transverse section through the stern of a vessel. Fig. 2, longitudinal vertical section of the same. Fig. 3, sectional plan view.

Two pairs of turbines are shown, one upon each side of the vessel. Each pair of turbines is fastened upon a vertically disposed spindle, A, which turns in a step upon the bottom of the cylindrical chamber B in the stern of the vessel, and rotated by a steam-engine.

The blades of the upper turbine C are disposed reversely to the buckets or the lower turbine D, and the shaft A must be turned so as to cause the former to take the water in above through the induction-aperture *a*, and the latter to take in the water below through the induction-aperture *b*, both turbines discharging the water into the space between them, from which it escapes through the passage E into a central chamber or cavity, F, in the stern of the boat, and issues from that through the eduction opening F' into the body of water in which the vessel floats.

Instead of taking in the water directly through the induction-apertures *a* and *b*, I prefer to cover said apertures by a rack, G, illustrated in Fig. 3, and draw the water through that. This rack is constructed with a series of vertically elongated openings, *g g*, which are divided from each other by the plates G'. The latter are arranged in oblique positions in the manner shown in Fig. 3, the effect of which will be to cause the ingoing currents of water to press upon these inclined planes, so as to assist, to some extent, in propelling the vessel.

In order to make this action of the water upon the oblique

Fig. 1.

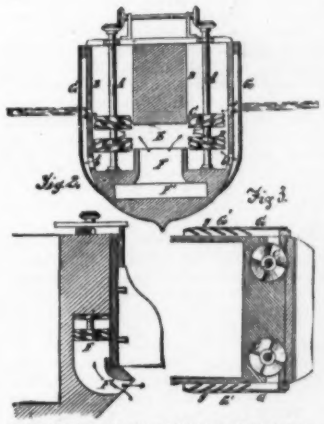


Fig. 2.

Fig. 3.

IMPROVED CANAL-BOAT PROPELLER.

surfaces of the plates as effective as possible, the openings in the racks should correspond in area as nearly as possible with the area of the eduction-aperture. The turbines may be arranged horizontally, if preferred; and where they are to be used for propelling boats in shallow water the chamber in which they operate should be closed air-tight.

[British Trade Journal.]

MESSRS. HADLEY BROTHERS' MITRE-CUT NAIL WORKS, BIRMINGHAM, ENG.

THE manufacture of cut nails in the great "Hardware Capital" has been carried on as a distinct branch of industry now for something like half a century. In the interim the high prices of hand-made wrought nails, and the inefficiency of cast nails as a substitute for them, has naturally stimulated the production of a variety of ingenious machines for stamping, cutting, and heading wrought-iron nails. Birmingham manufacturers were the first in England to adopt the American system of cutting nails out of cold metal by machinery. The principle and the main essentials to successful manufacture are still the same, but in certain details the machinery has undergone considerable modification and improvement. These details have reference to the simplification of parts and acceleration of speed, and in these respects the introduction of modern machinery has had an effect on the cost of production and quality of the article which are more or less advantageous to the buyers and users of cut nails. It is estimated that from 20,000 to 25,000 tons of iron are annually cut into nails in Birmingham, a total quantity equal to the aggregate production of nails of this class in all the other places in the United Kingdom. A large proportion of these nails are shipped for places abroad, especially India and the Australian colonies, and the remainder are absorbed in supplying the wants of the home trade. England bears the palm in this special manufacture. As a rule our cut nails are of very fine sample, manufacturers taking pains to select a superior quality of sheet iron, and using machinery of such precision that their nails are straight cut, well pointed and headed, and consequently English cut nails are much sought after by foreign buyers as really excellent nails for general work. The sorts of nails mostly required are — clasp, clout, and rose-head nails, used by builders, box-makers, coopers, etc.; cut tacks, in copper, zinc, and iron (the latter are exported very largely to Russia, made up in bags containing one Russian pood, equal to 36 lbs. English avoirdupois); slate nails, in copper, zinc, and iron; joiners' floor brads, shoe nails, namely, "bills," "hobs," "tip nails," etc.

Some account of a recent visit to the cut-nail manufactory of Messrs. Hadley Brothers, the largest and most complete establishment of the kind in England, may probably be interesting to the readers of this journal. "The Mitre-Cut Nail Works," as they are called (the "Mitre" being the registered trade-mark of the firm), were built especially for the purpose, under the personal superintendence of the principals, and thus every possible requirement has been anticipated in the most systematic manner, to insure order, regularity,

rapidity and economy in converting the raw material into the finished nail of commerce. The visitor, on going through the works, is naturally struck with the arrangement of the premises, which, from the portion set apart for the reception of the material, down through the sectional divisions of manufacture, to the final delivery of the finished goods into the carriers' wagons, betokens a special regard to convenience and efficiency. This is a matter of no small importance, since the machinery here employed is capable of cutting up 130 tons of iron per week—the nails produced embracing all the various kinds, from the tiniest tack, three-sixteenths of an inch in length, up to 7½-inch clasp, clout, or rose nail. The large quantity of iron required for feeding the nail machines would, of course, involve the employment of much additional labor if in any stage it had to be handled twice. The necessity for this is avoided by passing the iron in due sequence through all the processes of manipulation. A private arm of the Birmingham Canal forms one boundary of the works, and by this means the iron and fuel are delivered direct into the factory. At the entrance the iron sheets are weighed, one ton at a time. They are next gauged, to test their thickness, sorted, and passed down to the shearing shop, where they are cut up into strips, the width of the strip being regulated according to the desired length of the nail, and the thickness of the strip indicating the nail's thickness. The cutting is accomplished by means of guillotine shears. The operation is almost noiseless, the blade or cutter of the machine descending on the iron plate with a steady and irresistible force, a faint grating sound being the only audible evidence of its power. Some of these machines are constructed on a new principle, and their action is both perfect and rapid.

On the way to the nail mill the visitor passes the engine-room, in which are a pair of horizontal engines of high-class make, and a nominal power of 60 horses. These engines are supplied with steam from two out of three boilers in the adjoining yard. One boiler is at rest and two are at work, so that every third week the one not fired is at liberty for thorough overhauling and cleansing, a system which renders Sunday work or the stoppage of the works on week days for such purposes unnecessary, besides securing a constant supply of motive power. Whenever it is desirable to signal the engineman to go faster or slower, or stop the engine in case of accident, the operative in charge of a nail machine, in any part of the factory, has simply to clutch the nearest bell-pull, and the engine is stopped at once. This precautionary provision, we understand, renders any serious accident to life or limb of very rare occurrence. Entering the nail mill, the visitor is for the moment bewildered at the sight and sound of some hundred and fifty nail machines all running at high speed and turning out cut nails at the rate of, say, two or three hundred per minute. Some of these machines, at work on the smaller kinds, are fed with iron by young women; others, for the heavier sorts of nails, such as big spikes and large floor brads, are invariably fed by men. A number of the machines are self-feeding—that is, the young woman who supplies the thin iron strips to the jaws of the nail cutter is able to put in four or more strips at a time, each strip being properly disposed of by the voracious mechanism, and as quickly dropped (as in a "nail storm") finished goods into the iron pans on the floor. Each machine was formerly fed by a separate "hand;" but the inventor and machinist have changed all that, and now cold iron strip is placed in a "rest," or feeding rod, and allowed to pass automatically into the machine, so that one feeder, even if quite new to the work, is able to look after two or more machines. On the occasion of our visit the machines at work were engaged on nails of all sizes, such as shoe nails, joiners' brads, floor brads, etc. Two complete rows of machines were running on tacks, and to us the "make," on examination by picking up and inspecting an occasional handful, appeared perfect as to shape and uniformly true as to size.

The work, on leaving the machines, is immediately weighed, and the worker credited accordingly with the yield of his or her particular machine until settling day, at the end of the week. Every thing which has passed the weighing barrier goes into stock, and is taken charge of by the clerks and warehouse assistants. The annealing process has first to be gone through. As this is a very important matter, Messrs. Hadley Brothers pay especial attention to the annealing department. All nails that have been well annealed are able to stand a test of usage, both clenching and otherwise, that qualifies them for almost any purpose for which, formerly, hand-made or "wrought" nails alone were used. Indeed, for many purposes the cut nails, cut tacks, shoe bills, etc., made by this firm are preferable, on account of their regularity in size, shape, etc., besides being supplied at a much lower price. After being weighed the nails are handed over to another set of workmen, who place them in wrought-iron barrels, which are made air-tight, and then rolled into a burning fiery furnace or muffle, where the work is annealed. One peculiarity in the annealing is the facility with which the various kinds of nails are made just the degree of softness or temper required. Thus nails wanted only to drive straight are simply "blued," but if required to bend or clench, they are made soft and ductile by a longer application of the same process. When the barrels are drawn from the muffle they are gradually cooled, and their contents then removed to the warehouse, whence the finished goods are dispatched from spacious loading stages into the railway-wagons. Goods for the home market are packed in bags of coarse canvas, from a material locally known as "Dudley muslin;" all these bags are made on the premises by the work-people of the firm. Nails intended for shipment to India, China, and Australia—in fact for all distant voyages—are packed in water-tight iron kegs or drums. This mode of packing is very popular with the principal buyers abroad, not merely because it is safe, but also because these packages go in duty free, and when empty are invariably utilized, as each package, with the simple attachment of an iron handle, can be sold as a bucket.

An improved method of blueing tacks and other small nails is practised here. Formerly it was customary to put the work in an open pan, which was placed in an oven, and the pan being pulled out now and then, according to "rule of thumb," the nails would be raked over with the irregular and unsatisfactory result that some of the nails would be straw color, some half blued, and others burnt. At the Mitre Cut-Nail Works uniformly good results as to color are obtained by the employment of an iron cylinder, which is made to revolve, by the action of steam power, over a fire, and by this gentle and gradual process the nails are perfectly blued. "Nugget nails" are a small kind of hob nails much used by shoemakers. They take their modern name from the fact that the miners at the gold-diggings in California would have no other hob nail for their boots; but they have for years been known to the trade as "Hungarian" hobs. These nails are made in the usual way, and afterwards rendered bright as silver by being put into a revolving machine along with a copious supply of leather scrap, and subjected to a good deal of shaking. The tacks and small nails, when finished, pass into the packing-room, where upwards of thirty girls are employed in sets, doing them up into the neat little paper packets one sees on an ironmonger's shelves. Immense quantities of tacks are dispatched from these works for the Russian market; they are packed in Hessian canvas bags, containing a pood (36 lbs.).

The workshops throughout are well lighted and ventilated, and, together with the spacious dining and reading-rooms, are warmed in winter by steam pipes. There is no difficulty here about juvenile labor under the operation of the Factory Acts, since the firm found out long ago that there is no profit or advantage whatever in their trade in the employment of "half-timers," and no child is employed under thirteen.

One noticeable feature of this establishment is that each department is brought into complete harmony with all the others. All the tools, patterns, and machines are made and repaired within the works by a separate staff, and every operation is hedged in with adequate checks and safeguards to insure regular and good work. For example, it is one man's sole duty to take a sample of work from any machine when and so often as he chooses. This sample is "taled" and examined, and note taken as to whether the particular nails are made too heavy or too light, or in other respects not according to order, and steps are thereupon taken to insure more careful attention from the workmen in future. It is this system of rigid inspection that has secured Messrs. Hadley Brothers such a world-wide reputation for the quality of the nails made by them. The offices, it should be added, are so arranged that each department of the works is placed at one view under the eye of the principals or the acting superintendents, and this, superadded to the systematic "order," "invoice," and "warehousing" departments, tends to make even the longest day's work agreeably pleasant and profitable to all concerned.

THE KEROSENE OF NEW SOUTH WALES.

THE news of the Pennsylvanian oil-springs excited much attention in Australia. Though some colonists doubted whether we should find the liquid welling up among the gum-trees; others no sooner heard of the oil being distilled from bituminous schists than they set about searching for similar deposits.

The first decided success in the search came from near Hartley, in the Blue Mountains, 100 miles west of Sydney. The landscape of the neighborhood, now accessible by rail, is one of the most charming in Australia, and was much admired by the Duke of Edinburgh. The Hartley site is 2670 feet above the level of the sea. The stone was found cropping out in the alluvium of the celebrated Vale of Clwyd, so called from a fancied resemblance to the far-famed Welsh retreat. The enormous denudation of the sandstone formation in that quarter has originated some lovely and romantic features of scenery. Sir Thomas Mitchell, Surveyor-General of New South Wales, calculated that 134 cubic miles of rock were excavated to form the Valley of the Grose, which is 2200 yards wide, and having a depth of 1500 feet.

The Vale of Clwyd deposit is four miles from the township of Little Hartley. There is fine cannel in this neighborhood, among the York and Victoria Ranges of the Dividing Range. Like other kerosene shales, it leaves a brown mark when scraped with a knife. The seams are 5 and 6 feet thick. An interesting account of the discovery came in a letter to Sir Roderick Murchison from Mr. Fane de Salis, a director of the Australian Agricultural Company.

Mr. Humphrey, of St. David's Oilworks, near Chester, reported the material as "the most productive cannel for oil-making that I have ever examined." He obtained 58½ per cent of crude oil, being 152 gallons to the ton. The specific gravity was .86. The spirit, by analysis, was 8.85; the burning oil, 75.3; the lubricating oil, 32.24; the paraffin, 5.55; and the loss, 27.90, out of 150 parts.

Most of the New South Wales cannels may, perhaps, be similarly utilized, and thus continue to keep out American kerosene from the Australian market. The cannels are connected with beds containing Glossopteris; "though," says the Rev. W. B. Clarke, "all the deposits but the one at Stony Creek evidently belong to the upper coal formation." The Boghead cannel of Wallerawang, having a thickness of 14 inches, yielded 17,000 cubic feet of gas to the ton, possessing the illuminating power of 36 candles. Hassan's Walls, Colo and Grose rivers, Illawarra, Reedy Creek, the Hunter Valley, the Clodaice, McIntyre, and other streams, yield the material. Two seams of excellent Boghead are known at Colley Creek, north of Liverpool Range. The inflammable schist of Toonalli River presents itself from 900 to 1200 feet above the sea.

The works of Petrolia Vale are at the foot of Mount Victoria. Among the products of this valuable mineral, whiskey has been made from it. The Bog Butter, found north of Bournda, in the Twofold Bay District, is a remarkable substance. It is described as a dark yellowish brown clay-bed, one foot thick, saturated with volatile matter. This tertiary mud rests on sand and earth, with small quartz pebbles. The Bog Butter contained carbon, 8.75; clay and sand, 15; water, 48; tar-oil 8; gaseous, 19.

[Galaxy.]

THE GREATEST WASTE IN THE WORLD.

IT is a well-known fact that many of the artesian wells sunk for oil, in Pennsylvania and other parts of the country, failed to produce oil, but emit great quantities of gas. Some measurements and analyses lately made by Mr. O. Wuth, the well-known chemist, of Pittsburgh, Pennsylvania, go to show that, in the gas which is thus passing uselessly into the atmosphere we have a vast store of fuel, and that in allowing it to run to waste we have for years presented the most striking instance of extravagance in the world. The well he measured is named the Burns, and is on the Duffy farm, thirty-five miles from Pittsburgh. He found the composition of the gas to be C^1H^2, or 80 per cent of carbon and 20 per cent of hydrogen, with but little oxide of carbon and carbonic acid. The well has a tube of five eighths of an inch diameter, and the pressure of gas is no less than 200 pounds to the square inch. Its specific gravity is 1.56. On these data he estimated that the well yielded 1,000,000 cubic feet of gas, weighing 58½ tons, *per hour*.

This gas-well is therefore yielding 1408 tons of gas each day, and at the above composition it delivers 1126 tons of carbon and 283 tons of hydrogen a day. What these figures mean will be better understood by comparing the product of this well with other fuels. Mr. Wuth says that its heating power is 25 per cent above that of soft coal, but neglecting that and calculating from the amount of carbon, the 1408 tons of gas daily are equal to 1250 tons of the best anthracite coal; or to the charcoal that can be made from 5000 cords of wood. At a low estimate, this well yields as much carbon every day as can be obtained by clearing and charring the wood from 125 acres of prime forest lands. A mine that yields 1250 tons of coal daily is accounted a large one, though not the largest. If this gas could be made to smelt iron ores, as solid fuel is, it would make at least 700 tons of pig-iron daily.

It is evident that a well like this must be a prize if its gas can be utilized; but a greater question than the use of one well is whether the total supply from all the "blowing" wells is large enough to be of national importance. If we take the yearly production of iron at 2,600,000 tons, ten wells as large as the Burns would supply carbon enough for our whole make of iron. The coal-mines of the country produced, in 1874, somewhat less than 46,000,000 tons, and ninety five wells as large as the Burns could therefore take the place of our entire mining industry, if (which is not true) the gas could entirely replace coal. If we look upon these two numbers as extremes, it is quite certain that the blowing wells of Pennsylvania produce in the aggregate ten times as much gas as the Burns, and as there are some thousands of them, it is quite possible that they produce ninety-five times as much. As an indication of the great amount of gas now discharging itself into the air, we have a town lighted by the gas from one well, and three iron-mills employing the gas from others in their furnaces. The most important effort of this kind was successfully finished in October last. The Harvey well, a few miles from the Burns, was sunk just outside of the known oil region to test the possible presence of oil. It was not a success, but at the depth of 1200 feet gas was obtained in great quantities, and with a pressure of a hundred pounds to the inch. Some Pittsburgh manufacturers laid a six-inch iron pipe from the well to their works, a distance of nineteen and a half miles. When the gas was turned on, it travelled seventeen and a half miles in thirty-six minutes, or at the rate of thirty miles an hour. Five three-inch pipes were attached to the main at the mills, and from each of them streams gas enough to make a flame twenty feet long and six to eight feet wide. Apparently this well equals its rival, the Burns, in importance, and as many other large wells are known in Pennsylvania, it is quite probable that we may estimate the total amount of wasted gas at 100,000,000 of cubic feet per hour. If we take the whole number of blowing wells at 2500, the average product would be 40,000 cubic feet of gas every hour from each well.

These wells are capable of playing no unimportant part in the economy of nature. Forests are continually storing up carbon, which they draw from the atmosphere. If the forest lands of this country amount to 380,000,000 acres, and each acre grows one cord of wood per year (which would make a young forest worth cutting in forty years), we have a total of 380,000,000 cords of wood collected by the energy of plant growth from the earth and atmosphere in one year. A cord of wood will weigh 2800 pounds, and one half its weight will be carbon. The amount of carbon that our forests are storing away for us every year is, therefore, 237,000,000 tons. If we accept the maximum computation given above, that the wells send into the air 39,000,000 tons of carbon each year, they will supply enough to maintain the forest growth on 60,000 square miles of land, or one sixth of all our tree growth. The coal mined supplies the carbon for another sixth.

[British Journal of Photography.]

THE OXYHYDROGEN LIGHT.

NOTWITHSTANDING all that has been written about the lime-light, the question again and again crops up in one or other of its various forms; and in spite of the extreme simplicity and, when properly conducted, perfect certainty of all the operations connected with its production, operators are very far from being at one on various points connected with it. Several of these points have recently formed the subject of a rather animated discussion elsewhere; and, as the statements made by the various writers were either simply matters of opinion or conclusions arrived at on theoretical grounds, we resolved to institute a series of practical experiments, which—although they may not be of much value to experienced operators—will at least form the basis for the settlement of most of the disputed points.

Presuming that the source from which the oxygen is obtained is the ordinary mixture of potassium chlorate and manganic oxide, and taking for granted that the manganese gives up none of its oxygen, or at least so little as to be left out of consideration, our attention was first directed to a careful measurement of the actual quantity of oxygen evolved by the ordinary method of decomposition.

Potassium chlorate, as is evident from its formula, $K Cl O_3$, is made up of 35·5 parts by weight of chlorine, 39·1 of potassium, and 48 of oxygen, and as it is entirely converted into potassium chloride (K Cl) by heat, each 122·6 parts of the potassium chlorate should yield 48 parts of oxygen; or, to put it in a more convenient form, each pound should give exactly six ounces two hundred and thirty-six grains—equal, at ordinary temperature and pressure, to 4·42 cubic feet. Some operators are under the impression that they generally get a larger quantity of oxygen than this, while others believe that they rarely succeed in decomposing the whole of the chlorate; but the ordinary method of measurement, by calculating the capacity of the gas-bag, is extremely unsatisfactory, and, therefore, little reliance can be placed on results so obtained.

With a view to ascertain somewhat correctly the actual quantity evolved in practical operations, we obtained, through the kindness of the manager of one of our gas companies, two very delicate gas-meters, through both of which we passed the gas resulting from the decomposition of five different charges of one pound each of the potassium chlorate, and three ounces and eighty-eight grains of manganic oxide, one fifth being the quantity that in previous experiments we had found most advantageous. The retort was made of thin sheet-iron and conical in form, measuring five and a half inches at the base, seven and a half in height, and having a containing capacity of forty ounces. The source of heat was a *rose* Bunsen's burner, consuming 4·8 feet per hour—this small burner being, we think, much better than the larger sizes when quantities of not more than one pound are to be operated on—the decomposition going on gradually without any necessity for removing the flame and interruption to the flow of oxygen. The result of the five operations carried on in this way was that they gave a mean of 4·25 feet per pound—a difference of only 0·17 from the theoretical quantity, so that, practically, we may consider that the whole of the chlorate had been decomposed.

The next question was as to the relative value of pure hydrogen and ordinary coal-gas, as, although the latter is now generally used, we know there are some operators who take the trouble of making the former, under the impression that it gives a more brilliant light. Two bags were filled—one with oxygen and the other with pure hydrogen—and placed each under a pressure of fifty-six pounds. The jet was one of those in which the gases are mixed before reaching the

burner, and the hole in the latter measured $\frac{1}{100}$ of an inch—a size considerably smaller than we are in the habit of using, but chosen purposely to suit the limited space at our disposal in which to separate the photometer screen from the light.

The gases were carefully adjusted till the light was at its best, and its value was then ascertained by a modification of Bunsen's photometer, in which the candle was fixed at a distance of one foot from the screen, and the two together moved away from the light until both sides of the disc were equally illuminated. This was repeated very many times, and examined by various observers, the result being that a mean of all the observations gave the value of the lime light, under the above conditions, as 115·5 standard candles. In the next experiment, coal-gas was substituted for the pure hydrogen, and, somewhat to our surprise, the result was not to any appreciable extent different, the light being, both as shown by the photometer and in the judgment of those by whom we were assisted, in every respect equal to that given by pure hydrogen.

Between each of the gas-bags and the burners we had introduced one of the gas-meters, and carefully noted the relative quantities of gases consumed, the result being that with pure hydrogen it stood—oxygen 1, hydrogen 1·3; and with coal-gas—oxygen 1, hydrogen 1·1. We are aware that there is a very general belief that the proportions in which oxygen and hydrogen combine to form water (H_2O) are those which ought to give the best results in raising the lime cylinder to the incandescent state; but those who have had much practice with lime-light exhibitions, where the bags have been of nearly the same size, know very well that the hydrogen bag, especially when coal-gas is used, does not get empty much sooner than the one containing oxygen. What may be the true explanation of the apparent anomaly we are not at present in a position to say; but the result of the somewhat careful measurements above recorded is quite in harmony with the opinion that we had formed from our experience with the practical working of lantern exhibitions.

Of course it will be understood that in bringing the light up to only 115·5 candles, we were not seeking to produce the best effect that could be obtained, but only the best under the conditions named; with a view to comparing the pure hydrogen with coal-gas; and we may say that, on increasing the orifice of the jet to .08, and doubling the pressure, we more than quadrupled the illumination, and when it was passed through the ordinary lantern condenser it was roughly found equal to about 405 candles. To get at that estimate, however, the candle was fixed at only two inches from the photometer screen, and therefore there was some difficulty in deciding the precise distance from the light at which both sides became equally illuminated.

[Chemical News.]

RAPID MODE OF DETECTING THE ADULTERATION OF BUTTER WITH OTHER FATS.

By J. W. GATEHOUSE.

THE following method is based on the insolubility of potassium stearate in alkaline solutions, when the stearate has been produced at high temperatures.

Before the application of the test, it is essential that all curd, buttermilk, and salt be removed, and for this purpose the butter should be thoroughly washed in boiling water, and, if necessary, dissolved in ether.

Take about 20 grains of the butter, place it in a large test-tube—dimensions about 6 × ¾ inch—and fill the tube one third full with water, boil thoroughly, and allow to stand till the fat has accumulated at the top.

Two modes now present themselves—first, either to dissolve the fat in ether, and saponify after evaporation; or, secondly, and I think more conveniently, extract the lower layer of liquid by means of a pipette, which may be readily effected with a minimum of loss in the following way:

Draw out a piece of thin glass tubing, sufficiently long to reach to the bottom of the tube, to a fairly fine point, but not too fine, and bend the top to an obtuse angle. Whilst the butter is still liquid, insert this nozzle to the bottom of the test-tube by placing the finger over the upper end, so that no liquid may get in till it reaches the bottom of the tube. Allow it, now, to remain till the butter is cold and fairly set, when, by means of an inch of small caoutchouc tubing, attach to a sufficiently large pipette, and withdraw the whole of the liquid, the butter will, if sufficiently cooled, remain in the middle of the tube.

This process can be repeated till the washings show the absence of chlorides when tested with nitrate of silver.

The saponification is effected by heating the purified butter with from one third to one half its own weight of solid potassium hydrate perfectly free from salts of sodium (the best being the hydrate purified by alcohol) to a temperature above 420° F.

Eight grains of potassium hydrate easily saponifies the 20 grains of butter.

The heat should be applied gently at first, and when the frothing is becoming less, a higher temperature may be applied till no further apparent action occurs, and a porous mass remains at the bottom of the tube.

Should the butter be pure, the color of this mass will be, at the utmost, light yellow interspersed with a few light brown patches; but should the butter be adulterated to any extent, it may be almost black. Too much reliance, however, must not be placed on the color.

It is essential that the ultimate temperature during saponification be kept at above 400° for some minutes, else the potassium stearate formed will be soluble instead of insoluble in the alkaline solution. For this purpose in the first experiments, it is advisable to use a bath of molten tin or lead, but having once noticed the series of reactions which occur, the flame of the Bunsen burner can be used quite as conveniently and more advantageously.

Having allowed the tube and its contents to cool, boil the saponified mass with successive portions of distilled water till 6 oz. (or 200 cubic centimetres) altogether have been used. The absolute amount of water used is not material, but having once determined on the amount, it must be rigidly adhered to.

A portion of this solution poured into a test-tube half an inch in diameter will present only a faint opalescence if the butter is pure, but a decided opacity if impure, the degree of opacity depending on the amount of adulteration.

In order to determine the amount of adulteration in any sample, a pure butter should be first obtained from cream, which is easily effected by churning cream for from 15 to 30 minutes in a wide-mouth bottle, and adding to separate portions of its known percentages of lard, etc.

Saponify each of these as stated above, and cork them up in tubes of equal diameter, labelling each with the percentage of lard it contains.

On comparing them, it will be seen that 2 per cent of lard can be clearly indicated.

When a butter is analyzed, all that remains to be done is to saponify, make up the solution to the correct amount, and after cooling, pour out a portion into the tube, when comparison is easily made with the specimen tubes.

It is possible to weigh the amount of potassium stearate thus produced; but as the process of washing is tedious and the weighings never absolutely accurate, the comparison method is to be preferred.

[Manufacturers' Review and Industrial Record.]

ON SILICATE OF SODA IN TEXTILE INDUSTRY.

APPLICATION IN WOOL-SCOURING.

SILICATE of soda is now used in many places with the best success in washing and scouring wool. It must be remembered that for scouring the wool the temperature of the water and silicate of soda may be higher than in the treatment with soap and soda. For scouring the wool in the leviathan, only silicate of soda is added to the first bath instead of soda, and to the second bath only half the usual amount of soap and soda. It is advisable to squeeze the scouring liquor out thoroughly before washing the wool cold in the machine, as this liquor can be kept twice as long as soda or soap liquor, if it is only kept warm. The wool scoured with silicate of soda always appears more white, open, and soft; the latter is the case, however, only if the wool has been thoroughly squeezed before the cold washing. Wool treated in this way is, without question, cleaner, takes the dye more rapidly and better, and turns out whiter after sulphuring.

The same experience holds good of woolen yarn from which the grease is to be removed. It is sufficient to move them simply back and forward in very hot silicate of soda solution, to turn the skein on the stick, then to move them up and down on the stick in the hot solution, to squeeze, wring, or rinse in cold water, in order to obtain in this simple manner not only a beautiful, unfelted, clean white skein; nay, the yarn is much cleaner than if treated with soap, soda, ammonia, etc. (If the yarn is impregnated, also, with Irish moss, a little soda ought to be added to the silicate of soda.) On making a comparative test, for example, in this manner, by introducing a skein scoured with silicate of soda, and another cleansed with soda, at the same time, into an aniline bath, the former will take up the color brighter and purer in a quarter of the time of the latter; if they are now exposed to the sun, it will appear that the color of the former is also faster than the other.

As silicate of soda has no felting properties, it can not be used in fulling cloth. Still it would be difficult to find a better means of cleaning the cloths before fulling than by sprinkling a warm solution of silicate of soda over them while they are running over the rollers in the washing-machine. But the cloths must not be washed cold before the grease has been entirely removed in the washing-machine; on the contrary, they should first run through some pure warm water, which is poured into the machine for the purpose. The dirty liquor is run off, while the goods are being sprinkled with warm water, and they are then rinsed with cold water. This whole manipulation requires scarcely half an hour, as the grease and dirt are at once dissolved by the silicate of soda. Fugitive colors are attacked even less by silicate of soda than by soap; cochineal only, being an animal color, would disappear entirely.

APPLICATION IN BLEACHING.

In bleaching, silicate of soda has a great future before it; according to experiments which I have personally made in large scouring and bleaching establishments, I can positively assert that silicate of soda will displace the use of soda in bleaching. Even goods that hitherto could not be bleached without detriment to the fibre, *e. g.*, jute, become dazzling white in a very short time by the following process: Jute goods (yarn) are laid 15 to 20 minutes into a solution of silicate of soda at a temperature of 158 to 172 degrees F. (6 to 8 lbs. silicate of soda being taken to 100 lbs. of water), and turned several times with a stick; they are next rinsed in hot but not boiling water, followed by cold water, entered, as usual in bleaching, into a weak "bleach," and lastly into a "sour," and the conviction will be gained that jute can be used not only as the finest white material for paper, but also for the finest white fabrics.

Hemp and cotton yarn, instead of being boiled 6 to 8 hours in strong soda solution, are only moved up and down for 10 to 15 minutes in a very hot solution of silicate of soda. For 100 lbs. of linen yarn, about 12 to 15 lbs. of silicate of soda are used, which still cost 30 per cent less than the usual 10 lbs. of 90 per cent soda-ash. After the silicate of soda bath the yarn must be agitated once more in hot, pure water, and then rinsed cold, after which it is poured into a "bleach" and "sour" as usual. . . . . All baths, with the exception of the cold bath before the "bleach," which must be running constantly, can be used at least three times.

Linen and cotton fabrics can not be bleached in the same manner as yarn, as the sizing, consisting of potato-starch, glue, gum, etc., must be first removed by the weaver or by boiling in milk of lime; after this is done, the bleaching can, without a doubt, be accomplished quicker and cheaper with silicate of soda than with soda.

A NEW MATERIAL FOR FINISHING LINEN AND COTTON

Dr. H. Grothe gives the following instructions: Dissolve half the usual quantity of soda and rosin-soap, and for the other half put silicate of soda into the hollander. After these materials have been mixed in the hollander for a few minutes, add the solution of alum. This forms, with silicate of soda, likewise an insoluble gelatine in the shape of an exceedingly fine, snow-white powder, which is precipitated into all the fibres of the paper, whereby the paper not only appears much whiter and smoother, but also becomes more pliable and is increased in weight. The same precipitate of silicate of alumina is also used, instead of china clay, in finishing linen and cotton. It has the advantage of being much whiter, and is formed chemically in the finest fibres of the fabric. To produce it, let the linen or cotton pieces pass first through a hot solution of alum, and then through a hot solution of silicate of soda, to which a little glycerine is added; it is then passed through a weak solution of starch, and lastly between warm cylinders; the goods will come out uniform, and finished beautifully white.—*A. D. Polyt. Zeitung.*

[Gardener's Monthly.]

HOUSE PLANTS.

MANY of our readers have only a few window plants. These are often kept too warm, too wet, have too little sunlight, and have too many insects. In towns, in addition to all these, they have often too much of the fumes of burning gas. Leaks or escapes from the gas-pipe are well known to be an injury to plants, but it is not so well known that plants suffer, though in a less degree, from the common burning of coal-gas. The trouble with most room cultivators is to know when plants get too much attention. Too many insects are easily known, one—a single one—is by far too many. We still think there is nothing like coal-oil to destroy all kinds of insects. A very little, just enough to make a colored scum on the surface of a tub of water, is sufficient, and in this the insect-covered plant may be dipped, inverting the pot and plunging only the plant, and not the pot of course. If too much oil is used the plant may be injured. Too wet, is when a plant seldom gets dry—a healthy plant should get dry, and have light, dry-looking surface soil, every two or three days. As to heat, a temperature of about 55° or 60° is best for room plants; below that they do not flower freely; above they grow weak, especially if they have not a great deal of sunlight. Indeed, heat should be in proportion to direct sunlight on the plants.

Roses, when they are forced, do much better when the pots are plunged in some damp material. When no better plan offers, they may be set inside of a large pot, with moss between the space around. All plants that come into flower through winter should have those positions afforded them that have the most sunlight, especially the early morning light.

Ferneries are now so deservedly popular, that we must have a word to say for them at times, though their management is so simple, there is little one can say. It is probably their ease of management, and the great results obtained for the little outlay of care, that has rendered them so popular. It should not, however, be forgotten that the cases in which they are inclosed are not to keep out the air, but to keep in the moisture, as ferns will not thrive in the dry atmosphere of heated rooms. A few minutes' airing every day will, therefore, be of great benefit to them. Decayed wood (not pine), mixed with about half its bulk of fibrous soil of any kind, and a very small proportion (say a tenth of the bulk) of well-rotted stable-manure, makes a good compost. Most kinds particularly like well-drained pots. This is usually effected by filling a third of the pots in which the ferns are to grow with old pots broken in pieces of about half an inch square, on which a thin layer of moss is placed, before filling the pots, to keep out the soil from choking the drainage.

Many very pretty ferneries are made up entirely of native ferns, some species of which are within the reach of every one. Of the exotic ones, however, that are now general in most florists' establishments, and are remarkable for their elegance and beauty, we may name, Selaginellas (formerly Lycopodiums), S. stolonifera, S. densa, S. Mertensii, S. denticulata, S. cordifolia, S. flabellaris; Adiantum concinnum, A. pubescens, A. cuneatum; Pteris longifolia, P. serrulata, P. hastata; Polypodium Sieboldii, P. glaucum; Doodia caudata, Gymnogramma chrysophylla, Platyloma rotundifolia, Nothoclæna nivea, Pteris geraniifolia, Hemionites palmata. This will form a good and easily obtained collection to commence with. Ferns are easily raised from seed. Shallow pans of very sandy soil should be procured and filled within an inch of the rim. The seed, which is obtained from the brown lines or spots (called by botanists, Sporangia) on the under surface of most mature fronds, should be sown on the surface of the soil, well watered with a very fine rose, window-glass placed closely over the pans, to keep in the moisture and keep out small insects, and the pans themselves set in a heat of about 50°, when the spores will germinate in about two months.

Where the air is dry, if in rooms or greenhouses, frequent syringings are of much benefit to plants. Besides, cleanliness keeps down insects and checks disease in plants as in animals. Most old-fashioned lady gardeners (and may we ever bless them for the many lessons they have taught us!) take every opportunity to set their window-plants out of doors when a warm shower happens to occur. In winter a rain at a temperature of 40° or 45°, which often occurs, might be called a "warm shower." Cold water does not have half the injurious effect on plants that cold air has. When plants get accidentally frozen, the best remedy in the world is to dip them at once in cold water and set them in the shade to thaw.

It is better to keep in heat in cold weather by covering, where possible, than to allow it to escape, calculating to make it good by fire-heat, which is, at best, but a necessary evil. Where bloom is in demand, nothing less than 55° will accomplish the object; though much above that is not desirable, except for tropical hot-house plants. Where these plants are obliged to be wintered in a common greenhouse, they should be kept rather dry, and not be encouraged much to grow, or they may rot away.

After Cyclamens have done blooming, it is usual at this season to dry them off; but we do best with them by keeping them growing till spring, then turning them out in the open border, and re-pot in August for winter flowering.

Mignonette is much improved by occasional waterings with liquid manure.

In managing other plants, where there are several plants or varieties of one species, and command of different temperatures, it is a common plan to bring some forward a few weeks earlier than others in the higher heat, thus lengthening the season of bloom. This applies particularly to camellias and azalias; the former are, however, not so easily forced as the latter, being liable to drop their buds, unless care be taken to regulate the increased temperature gradually.

NEW-YORK ACADEMY OF SCIENCE.

THE Chemical Section of the Academy met January 10th, 1876, President J. S. Newberry in the chair. The president made some interesting remarks in regard to the age of the coal deposits of China, which he believed to be more recent than the carboniferous of our own country. The fossil plants found in them indicate that they belong to the Triassic and Jurassic. Plants, he contended, if carefully studied, are quite as reliable as other fossils in determining the age of strata.

Mr. W. Falke stated his observations in regard to the death of frogs. When frogs die a natural death, he said, a short time before they die they become boisterous, make a peculiar audible sound, and frequently jump out of the aquarium where they are kept. Frogs that are nearly starved become quite pale, but the color returns almost instantly when they are fed, some parts of the body becoming deeper in color than others, which intensity of color shifts about.

An interesting discussion followed in regard to the Emma Mine. The president stated his belief that it was a true mineral *vein*, and in fact the formation of *pocket* of silver was apparently an impossibility. This idea of the true fissure nature of the deposit, although the vein had apparently stopped, owing to some dislocation or fault, was confirmed by the discovery of a similar deposit of ore some 250 feet lower down in the same line by the tunnel company that are now piercing the Emma Hill.

ON THE TRANSMISSION OF MUSICAL TONES TELEGRAPHICALLY.

By ELISHA GRAY.

[Read before the American Electrical Society, March 17th, 1875.]

WHILE engaged in studying the phenomena of induced currents, I had noticed a sound proceeding from an electro-magnet connected in the secondary circuit of a small Ruhmkorff coil which was at that time in operation. This, of course, was not new (in having been observed by Page, Henry, and others, that the magnetization of iron is accompanied with sound), but it helped to direct my mind to the subject of transmitting musical tones telegraphically. Subsequently, I made a discovery that led to a thorough investigation of the subject, and I have devoted my whole time since then to the study which it suggested.

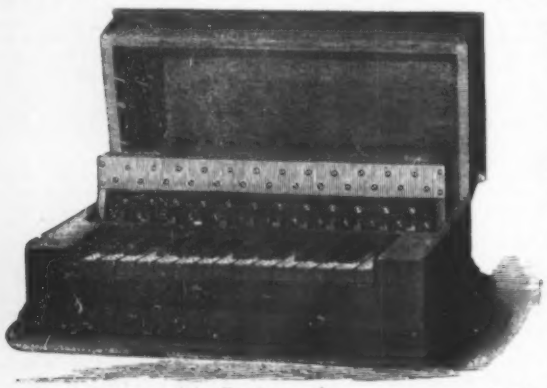


FIG. 1.

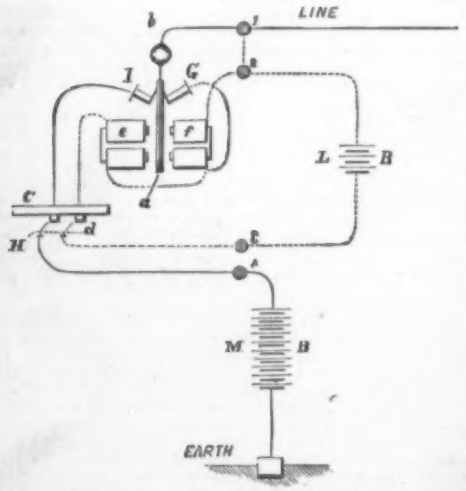
The circumstance was as follows: My nephew was playing with a small induction coil, and, as he expressed it, was "taking shocks" for the amusement of the smaller children. He had connected one end of the secondary coil to the zinc lining of the bath-tub, which was dry at that time. Holding the other end of the coil in his left hand, he touched the lining of the tub with the right. In making contact his hand would glide along the side for a short distance. At these times I noticed a sound proceeding from under his hand at the point of contact, which seemed to have the same pitch and quality as that of the vibrating electrotome, which was within hearing. I immediately took the electrode in my hand, and, repeating the operation, to my astonishment found that by rubbing hard and rapidly I could make a much louder sound than the electrotome was making. I then changed the pitch of the vibration, increasing its rapidity, and found that the pitch of the sound under my hand was also changed, it still agreeing with that of the vibration. I then moistened my hand and continued the rubbing, but no sound was produced so long as my hand remained wet; but as soon as the parts in contact became dry the sound reappeared.

The next step was to construct a key-board, with a range at first of one octave, similar in appearance to the cut shown in Fig. 1, which has two octaves.

Each key has a steel reed, or electrotome, tuned to correspond to its position in the musical scale. A better understanding of the operation of a key and its corresponding electrotome may be obtained by referring to the detached section shown in Fig. 1 *a*.

a is a steel reed tuned to vibrate at a definite rate corresponding to its position in the scale. One end is rigidly fixed to the post *b*, while the other end is left free, and is actuated by a local battery. The magnets *e* and *f* are arranged in the same local circuit, magnet *f* having a resistance of about thirty ohms, and magnet *e* about four ohms. When the reed *a* is not in vibration, the point C is in electrical contact with it, which throws a shunt wire entirely around the magnet *f*; thus, practically, the whole of the local current passes through magnet *e* at the instant of closing the key C. It is well known that when two electro-magnets are placed in the same circuit, the one which has the higher resistance

Fig 1a



(other things being equal) will develop the stronger magnetism, and that if the magnet of higher resistance be taken out of the circuit, the force of the other will be increased. When the key C, being depressed, closes the local circuit at *d*, the operation of the reed is as follows: The whole of the current from battery L passes through the magnet *e*, which attracts the reed say with a power of four. When the reed has moved towards I far enough to leave the point G, the shunt circuit is broken, and the current flows through both the magnets. Immediately, the power in *f* rises from zero to five, and that of *e* drops from four to one, and the reed is attracted toward *f* with an effective force of four, until contact is again established with the point G. The operation is repeated at a rate determined by the size and length of the reed, and which corresponds with the fundamental of the note it represents. The figures given above only approximate the facts. The relation of the magnets as to size and resistance, so as to give an equal impulse to the reed in both directions, was determined by actual experiment with a battery of a given size.

It will be observed that by this arrangement the centre of vibration coincides with the centre of the reed when at rest, so that the pitch of the tone is not disturbed by any ordinary change of battery, as is liable to be the case when only one magnet is used, or when the impulse is not equal in both directions.

A second battery, which we will call the main battery, is connected as follows: One pole is connected to the ground; the other runs to the instrument, and, entering at binding screw 4 (Fig. 1 *a*), runs to point H of key C; from key C to point I, which makes contact with the reed *a*; from reed *a* to binding screw 1, and thence to line. It will be seen that when the key is at rest the batteries are open at the points *d* and H.

All the keys in the instrument, whether one or more octaves, have corresponding reeds and actuating magnets, the only difference being in the tuning of the reeds. There is but one main and one local battery used, and the connections to each key are run in branch circuits from the binding-screws as shown in Fig. 1 *a*. But since all these branches are open at the key-points, neither of the batteries is closed unless a key is depressed.

If now the keys are manipulated, a tune may be played which is audible to the player. When any key is depressed, the local battery sets in vibration its corresponding reed, which sounds its own fundamental note according to the law of acoustics. So far the instrument is an electrical organ, the motive power being electricity instead of air. The main battery has had no part whatever in its operation.

If, however, the main circuit is closed by connecting the distant end to ground, and the point I is properly adjusted so that it makes and breaks contact with the reed at each vibration, a series of electrical impulses, or waves, will be sent through the line, corresponding in number per second to the fundamental of the reed.

Now, as the pitch of any musical tone is determined by the number of vibrations per second made by the substance from which the sound proceeds, it is clear that if these electrical waves can be converted into audible vibrations at the distant end of the line, whether it be one mile or five hundred miles from the player, the note produced will be of the same pitch as that of the sending reed.

There are various ways by which these electrical waves may be converted into audible material vibrations. One of the

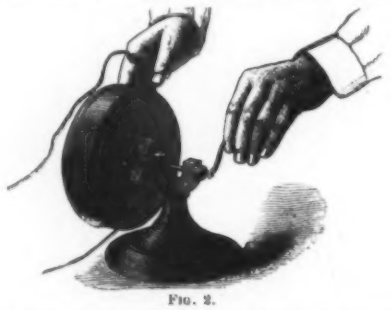


FIG. 2.

most curious and novel is the one in which animal tissue plays a prominent part. Following out the idea suggested by the bath-tub experiment, I constructed various devices with metallic plates for receiving the tune by rubbing with the hand. A very convenient method for doing this is shown in Fig. 2.

This instrument has a metal stand of sufficient weight to keep it in position while being manipulated. Upon the stand a horizontal shaft is mounted in bearings, upon one end of which is a crank, with a handle made of some insulating substance. Upon the other end is centred a thin cylindrical sounding-box, made of wood, the face of which is covered with a cap made of thin metal, spun into a convex form to give it firmness. This box has an opening in the centre to increase its sonorous qualities. The metal cap is electrically connected to the metal stand by means of a wire.

If the operator connects the cap, through the stand, to the ground, and taking hold of the end of the line with one hand, presses the fingers against the cap, which he revolves by means of the crank with the other hand, the tune that is being played at the other end of the line becomes distinctly audible, and may be heard throughout a large audience-room. If the conditions are all perfect, the faster the plate is revolved the louder will be the music, and the slower the motion the softer will it become. When the motion stops the sound entirely ceases.

I have found that electricity of considerable tension is needed to produce satisfactory results, at least that of fifty cells of battery. The necessary degree of tension is most conveniently obtained by passing the line current through the primary circuit (adapted to the circuit wherein it is used) of an induction coil, and connecting the receiver in the secondary circuit.

The cause of this phenomena has been the source of much speculation and experiment. At first, I supposed it to be the quivering of the muscles of the hand, produced by the electric impulses and communicated to the plate and box, making an audible sound, and that the motion was produced through the medium of the nerves. This idea, however, had to be abandoned. While visiting England, in 1874, I called on Professor Tyndall at the Royal Institution, and exhibited to him a portion of my apparatus. He experimented with various substances, and found that the same result, in kind if not in degree, could be produced with dead animal tissue. For instance, a bacon rind that had been pickled and smoked until there could be no suspicion of a nervous influence left, would, when sufficiently pliable, produce the sound, the cuticle being used next the plate.

While Prof. Tyndall's experiments did not explain what the cause of the phenomenon really was, they determined most conclusively that it was *not* due to nervous influence upon the tissues, acting in sympathy with electrical impulses. It was suggested by some that it might be caused by electrical discharges, in the form of a spark, from the hand to the plate; but if this is true, why should motion, as a gliding of the hand over the surface of the plate, be necessary to produce the result? Others have suggested that the molecules of the substance in contact were disturbed upon the passage of each electrical impulse, roughening the surface, and for the instant producing a sudden increase of friction. If this is true, why should wetting the parts in contact destroy the effect?

But to continue my experiments: I noticed that when revolving the plate with my finger in contact, the friction was greater when a note was sounding. I then connected a small Ruhmkorff coil to a battery, inserting a common telegraphic key in the primary circuit, instead of the self-acting circuit-breaker. I connected one end of the secondary coil to the metal plate, and holding the other end in my hand, I rubbed the plate briskly, and had my assistant slowly make dots with the key. I noticed at each make of the circuit a slight sound, and at each break a very much louder one, owing to the fact that the terminal secondary wave is much more intense than the initial. I now held my hand still, and, while I could feel

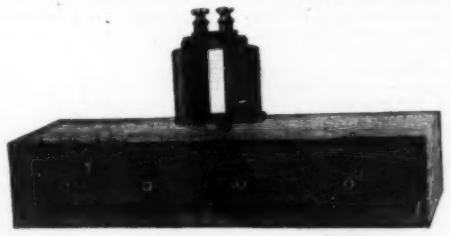


FIG. 3.

the shock just as distinctly as before, there was no audible sound, proving that the motion was a necessary condition in its production. The sensation when the sound was produced was as though my finger had suddenly adhered to the plate, and then as suddenly let go, producing a sound.

The next experiment was with one hundred cells of gravity battery. I connected one pole to the plate and held the other in my hand, pressing my finger against the plate and revolving it as before. I inserted a thin piece of paper between my fingers and the plate to prevent painful effects from the current, and my assistant made dashes with a key in the circuit. I was thus able to notice the effect of an impulse of longer duration. When the key closed there was a perceptible increase of the friction, so that my finger took a position farther forward on the plate, where it would remain as long as the circuit remained closed. As soon as the key was opened my finger suddenly dropped back on the plate, making the same noise I had before heard. This operation was repeated so often that there could be no question as to the effect it produced.

From the foregoing experiments, I find that the following conditions are necessary to reproduce musical tones through the medium of animal tissue, by means of electric waves transmitted through a telegraph wire.

1st. The electrical impulses must have considerable tension in order to make the effect audible.

2d. The substance used for rubbing the receiving plate must be soft and pliable, and must be a conductor of electricity up to the point of contact, and there a resistance must be interposed, very thin, neither too great nor too little.

3d. The plate and the hand or other tissue must not only be in contact, but it must be a rubbing or gliding contact.

4th. The parts in contact must be dry, in order to preserve the necessary degree of resistance.

It will be seen that we have here the conditions of a static charge, the plate receiving one polarity from the battery, and the hand the other polarity; the interposed resistance preventing in a great degree the dynamic effect. It is a well-known fact that two bodies statically charged with opposite electricities attract each other. May not this be the whole solution of the phenomenon, that each wave as it arrives at the receiving end becomes for a moment static, which results in a momentary attraction between the plate and the finger, and this immediately ceasing when the wave is gone, releases the finger with a noise or sound? If, then, sounds are repeated as fast as the sending reed vibrates, the production of a musical tone must follow, according to well-known laws of acoustics, providing the waves are sent to line in musical order.

In the winter of 1873–4, I experimented very elaborately,

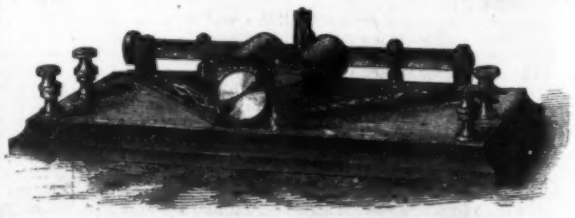


FIG. 4.

and worked out many new applications of the principle, not only to the transmission of music, but to the transmission of telegraphic messages.

If, instead of the revolving plate and the animal tissue, we place in the circuit an electro-magnet, or a number of them, and have a tune played at the transmitting end, the tune will be heard from all these electro-magnets. The music produced will be loud or low; 1st, as the battery used is strong or weak; 2d, as the line offers more or less resistance; and, 3d, as the magnets are mounted more or less favorably for acoustic effect.

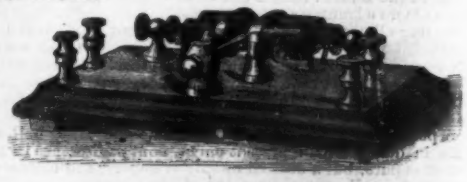


FIG. 5.

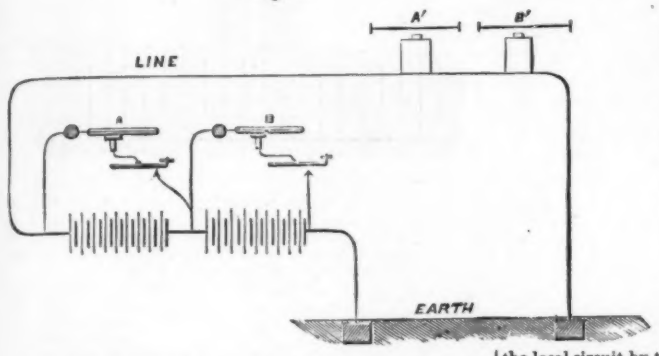
In this case, as in that of the animal tissue, each impulse produces a sound; but it is produced differently in the two. It is a well-known fact that an iron rod elongates when magnetized, and contracts again when demagnetized. The elongation and contraction are so sudden, that an audible sound is produced at each change. In order to convert this sound into a musical tone, it is only necessary to repeat it uniformly and at a definite rate of speed, which shall

not be less than sixteen nor more than four thousand per second.

When the electro-magnet is properly mounted the tone may be made very loud. Fig. 3 shows a very good form for mounting a magnet for receiving music. It is a common electro-magnet having a bar of iron rigidly fixed at one pole, which extends across the other pole, but does not touch it by about one sixty-fourth of an inch. In the middle of this armature a short post is fastened, and the whole mounted on a box made of thin pine, with openings for acoustic effects.

One of the earliest discoveries in connection with these experiments was the fact that not only simple but composite tones could be sent through the wire and received, either on the metal plate or on the magnet. Not only could a simple melody be transmitted, but a harmony or discord could be equally well. From that time, I have worked assiduously with the view of making a rapid telegraphic system embodying this discovery. The first step was to analyze the tones at the receiving end, which, if successfully accomplished, would open the way to a multiple Morse, a fast-printing, an autographic, and other systems.

Fig 6.



It would be impossible to give in this paper all the experiments tried, for they were very many indeed. I accomplished the analysis in a number of ways. The method which seemed in all respects to give the best satisfaction is as follows:

Fig. 4 is a perspective of one form of a receiving instrument called an analyzer. The construction of the instrument is very simple. It consists of an electro-magnet adapted to the resistance of the circuit where it is intended to be used, and of a steel ribbon strung in front of this magnet in a solid metal frame, and provided with a tuning-screw at one end so as to readily give it the proper tension. The length and size of the ribbon depend upon the note we wish to receive upon it. If it is a high note, we make it thinner and shorter; if a low note, we make it thicker and longer. If this ribbon is tuned so that it will give a certain note when made to vibrate mechanically, and the note which corresponds to its fundamental is then transmittted through its magnet, it will respond and vibrate in unison with its transmitted note; but if another note be sent which varies at all from its fundamental, it will not respond. If a composite tone is sent, the ribbon will respond when its own note is being sent as a part of the composite tone, but as soon as its own tone is left out it will immediately stop. Thus I am able to select out and indicate when any note is being sent, in fact, to *analyze* the tones which are passing over the line.

This method of analyzing tones transmitted through a wire electrically is analogous to Helmholtz's method of separating tones transmitted through the air.

The transmitting instruments used in sending composite tones are made similar in every respect to the one shown in Fig. 1 *a*, except that each reed is separately mounted. A cut of one of these transmitters, used in telegraphic work, is shown in Fig. 5.

Fig. 7.

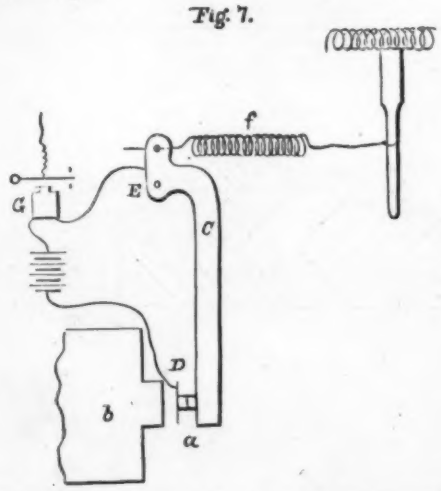


Fig. 6 shows a diagram view of two transmitters and two receivers, with their connections. The local circuits, with their magnets, are left off to avoid confusion.

A and B represent two transmitters, placed at one end of a line; A′ and B′, two receivers at the other end. One end of the main battery is connected to line, and the other end to ground. Each transmitter is placed in a shunt wire, running from its main battery connections around one half of the battery. A common open circuit-key is placed in each of these shunt wires. Suppose now the two reeds of A and B to be sounded, A making 264 vibrations per second, and B 330, just two tones or a major third above A. So long as the keys remain open, the battery is all on the line steadily. If the key of transmitter A is closed, half of the battery is being thrown on and off the line, at a rate of 264 times per second. This causes a succession of electrical waves to flow through the line at the same rate. If now the steel ribbon of the analyzer A′ has been tuned in unison with these electrical waves, it will respond and hum the same note as the transmitter; but if it is not in unison, it will remain practically quiescent, so that the note can only be heard by submitting it to the most delicate test. To bring it in unison, it is only necessary to turn the tuning-screw up or down, as the case may be. When the fundamental of the ribbon corresponds with that of the sending-reed, it announces the fact by sounding out loud and full. If (having the key of transmitter A still closed, and consequently its corresponding analyzer still sounding) we close the key belonging to transmitter B, the other half of the battery will be thrown on and off the line, at the rate of 330 times per second, and another succession of electrical waves will flow through the line, this one being at the rate of 330 times per second. If the analyzer B′ is in proper tune, so that its fundamental is the same as that of its corresponding transmitter B, it will hum its note as long as the key is closed, making a chord with A′. In the same way, a great number of different notes may be sounding at the same time, at one end of a telegraphic line, and be heard simultaneously at the other end, each note sounding upon a different receiving instrument.

The manner of making these vibrations of the analyzer operate a sounder, a register, or other recording instrument, is shown in the detached section of the analyzer, at Fig. 7. In this *a* is a cross-section of the steel ribbon, *b* the electro-magnet, C a light metal bar pivoted at E, D a platinum point resting against another on the ribbon *a*, and *f* an adjusting spring by which the pressure of lever C, at point D, against the ribbon *a*, is regulated. One pole of the local battery is connected to the steel ribbon, through the frame of the instrument. The other runs through the sounder-magnet G, and thence to the lever C, completing the circuit at the point D. The tension of the spring *f* is so regulated that the rate of vibration of the lever C is naturally slower than that of the ribbon *a*. The operation is as follows: When the operator, at the sending station, closes his key, the ribbon *a* is thrown into vibration, and remains so as long as the key continues closed, but comes to rest immediately when the key is opened. The lever C, not being able to follow the ribbon, rattles against it with a buzzing sound, disturbing the continuity of the local circuit by throwing in a great resistance at the point D. This resistance is sufficient to act upon the sounder the same, practically, as a dead break. By this means the sounder is made to follow the key of the operator who is sending the proper note. In the same manner all the other tones may be brought into service, each ignoring the other, and each seeking its own at the receiving end.

By this method, not only may different messages be sent simultaneously, but a tune with all its parts may be sent through hundreds of miles of wire, and be distinctly audible at the receiving end.

A successful experiment was made at Milwaukee, Wis., on January 8th, 1876, with Mr. Gray's system. A loop was arranged by way of Horicon to Portage and back by way of Watertown, a distance of 200 miles. Over this single wire eight operators sent messages and signals in the same direction at the same time, without any one interfering with another. The experiment was witnessed by a number of telegraphers and representatives of the press.

HISTORY OF THE SUEZ CANAL.

As England is likely to become the chief proprietor of this famous canal, it may not be without interest to glance briefly at its history.

The old Egyptians were great constructors. The pomp and pride of the Pyramids is not their only work. They had also their Suez Canal. It was planned and perhaps partially executed by Sesostris, and connected the Nile with the Red Sea. Pharaoh-Neco later reconstructed it, or was the author of the conception, and sacrificed many thousands of human lives in order to carry it into execution. The work was carried on by Darius and completed by Ptolemy II. The motive of the old canal was not that of the present. Egypt wanted a port on the Red Sea for the transport of her own produce and for trade with the East, and her famed wisdom did not take into account the future of Europe and her barbarian tribes. It is said that about A.D. 635 Amron caused a canal to be made for the transport of corn from Egypt to Arabia. Probably he only renewed the old one, which a century and a half later was closed on the side of the sea by the command of the Albuzia-far Almanzor II. Caliph of the Abbasides, in order to prevent supplies going to Medina, then in the hands of a descendant of Ali. The memory of this old canal did not entirely die out, and from time to time suggested the thought of uniting Europe and Asia. The Academy of Sciences of Paris in 1701 had an enthusiastic member who prophesied that should it ever be renewed, posterity would lament the fate of the barbarous ages when the Europeans were obliged to go round Africa to get into Asia.

The poet tells us that,

"Through the ages one increasing purpose runs,
And the thoughts of men are widened by the process of the suns."

The Suez Canal of to-day is an example of this truth as compared with its feeble predecessor. It is a great instrument in the cosmopolitan spirit which is every year bringing remote people into closer commuuion, abridging distance and lessening the toil of traffic and travel. It is also the monument of one man—Ferdinand de Lesseps—whose energy and determination have overcome difficulties that would have daunted a fainter heart. Thirty years before its accomplishment the subject had occupied the thoughts of the young French diplomat. The natural difficulties were not the only ones, and probably not the greatest that had to be overcome. Lord Palmerston denounced it on political grounds, and many considered it to be the offspring of political intrigue. Then there were difficulties with the Porte, jealous of the semi-independence of the ruler of Egypt. The engineering problems to be solved were grave and troublesome; all these were overcome. Port Said was constructed in the Bay of Pelusium, the site aptly named from the mud of which it was composed. Thence the canal had to pass through a plain of black mud extending for 28 miles. Fifteen thousand fishermen were employed in scooping out a channel into which dredging machines could be introduced. Passing from Lake Menzaleh the canal passes Kantara, once a flourishing city of 500,000 inhabitants, which lying waste for centuries has once more become the abode of men. The canal then passes another lake, sometimes dry, and forming twelve miles of barren desolation. The marshy plain is in several places marked by rising ground. A machine had to be devised capable of throwing the silt over these prominences. At the termination of Lake Ballah the desert begins. After some slight undulations a mound 55 ft. high and 650 ft. in length was encountered, and further on the Seuil d'E Guisr rose, a rampart of 61 ft. Twenty thousand men were employed in removing the obstacle. The drinking water of this industrial army had to be brought twenty miles, a day's journey for the "ships of the desert," of which 2000 were employed. A system of dry dredging was invented to complete the work of the fellaheen. A little further than El Guisr we come to Lake Timsah. In the midst of the trackless desert which succeeds it the town of Ismaila was constructed. The canal crosses the Secil of Serapeum thirty feet above the level of the sea, and seven miles in continuance. The old world and the new are strangely united, for here is a hill named, according to Arab tradition, after Miriam, the sister of Moses. In 1862 not less than 12,000 men were employed upon the fresh-water canal in the direction of Suez. This was pushed on in advance of the ship canal, so that the laborers on the latter found water ready for their use. It was not until 1869 that the waters of the Mediterranean entered the Bitter Lakes. From thence the land rises, until it becomes the Seuil of Chalouf, where the hard bank of rock had to be blasted by gunpowder. The dredgers could not be floated in, as was done at the Serapeum. The excavation was done by hand labor. After countless difficulties had been surmounted, at last on the 15th August, 1869, the Red Sea and the Mediterranean joined their streams in a common channel. The formal "inauguration" took place with great pomp in November.

Genius was justified of her son, and the "practical" men who had denounced the entire project as a delusion were brought to see that the obstacles which nature, diplomacy, and apathy had opposed to the undertaking were alike in vain. An eminent English engineer has declared that, apart from its by no means commonplace engineering difficulties, the Suez Canal reflected "an amount of credit upon a single individual such as had scarcely ever been earned by one man before."

The funds for this gigantic undertaking were furnished by a joint-stock company, "Compagnie Universelle du Canal Maritime de Suez." The Khedive took a heavy venture in it; half the shares were taken in France, a quarter in Egypt, and a very few in England. The emphatic declaration against the canal of Robert Stephenson, the engineer, had great weight here, and Lord Palmerston was probably not alone in regarding it as a political move directed against English interests in the East. Various modifications were made from time to time in the constitution of the company and in the nature of the concessions granted to it by the Khedive of Egypt.

The total length of the ship canal is 77 miles, and when examined immediately on its completion with a view to test its capabilities for navigation, it was found that there was not less than 20 feet of water in any part of it. The Canal brings India 5000 miles nearer to our doors. The steamship Danube, with 4000 bales of cotton, which left Bombay on the 12th February, 1870, was the first vessel that came to Liverpool by the new route, where it arrived on the 22d March. On the 29th of the same month samples of the manufactured yarn were sent back by the same vessel to Bombay. The voyage occupied 45 days. The old route would have taken from 100 to 120 days.

The success of the canal was shown by the passage through it of several English troop-ships. They were upwards of 4000 tons each, 300 feet long, and drew 22 feet of water. Two of these passed through in 17 hours each.

England has no claim to the honor of aiding the adventurous spirit who made the Suez Canal, but since its completion she has been its best customer. In the last year above given the British vessels were 69 per cent of the total number, and their tonnage was 71 per cent of the total amount. The revenue of the company in that year was £911,032, of which British interests contributed £647,833. The amount sunk in the company is said to have been: subscribed capital, £8,333,333; loan of 1867-8, £4,166,625; loan of 1871, £833,333; total, £18,333,291. The revenue of the canal is over 30,000,000 f. yearly.

[Engineering and Mining Journal.]

THE RETAIL PRICE OF BITUMINOUS COAL IN NEW-YORK.

It has long been a matter of surprise that our excellent domestic bituminous coals have so limited a sale in this city, and that they have not driven foreign coals from this market. The reason is not hard to find, and the remedy is in the hands of the "miners and shippers" of the coal. According to our regular market reports the retail and wholesale prices of bituminous coals are as follows:

	RETAIL, per 2000 lb.	WHOLESALE, per 2240 lb.
Liverpool House Orrel, delivered	$23 00	$13 00
Liverpool House Cannel "	25 00	20 00
American " "	15 00	11 00
Kanawha Splint "	15 00	6 50
American Orrel "	11 00	6 50
Red Bank Cannel "	14 00	8 50
Cumberland "	7 00	5 50

We note for example that Kanawha splint, one of the best and most satisfactory grate coals that could be desired, sells here, wholesale, by the cargo, at $6.50 per ton of 2240 lb., while it retails at $15 per ton of 2000 lb., a difference of $9.20 or 159 per cent, by way of commission, for "handling" the coal. This outrageous charge has for effect to make our bituminous coals an article of luxury, and to greatly hinder the development of the trade.

A few dealers have the entire retail trade in bituminous coals in their hands, and instead of seeking to extend the use of American coal, by selling it at a fair price, say $7 to $8 a ton, at which price it would drive foreign coal from this market, they seem to be anxious to keep the price of American coal at such a figure as will enable them to keep an exceedingly lucrative, though small, business in foreign coal.

Let some of our West-Virginia mining companies, the Cannelton or Coalburg, for example, or the Red Bank (Pennsylvania) Company, establish retail yards here, and sell their coal at reasonable prices, and the consumption of American coals will increase enormously, and it will render the importation of foreign coal impossible.

[Advertisement.]

AMATEUR WOOD-WORKERS

Can find every thing they require in rare and fancy woods, planed ready for use, at Geo. W. Read & Co.'s, 186 to 200 Lewis street, New-York. Send 3-cent stamp for catalogue and price-list. We also call the attention of manufacturers to our general price-list of hard-wood lumber and veneers.

LESSONS IN MECHANICAL DRAWING.

By PROF. C. W. MACCORD, STEVENS INSTITUTE.

(Continued from page 84.)

LESSON III.

BEFORE going farther in giving examples for practice, we will say a few words in regard to drawing in ink; because, probably, the majority of our readers intend to acquire the use of the pen as well as of the pencil, and those who do should by all means begin practicing with it at once.

Probably none of them need to be told that pencil-lines, being more or less liable to defacement by handling the paper, are unsuitable for "working drawings," intended for the guidance of the workman in constructing the object represented; or are unaware that the most carefully-executed pencil-drawing can not compare with one finished in ink. But there may be some who do not know that common ink is wholly unsuitable for this purpose; it corrodes the pens; it acts chemically upon and bites into the paper, and it has not the brilliant blackness which is desirable.

Fig. 26.

India-ink, then, is exclusively used for the black lines of mechanical drawings. It consists merely of carbon mixed with some adhesive substance, and lies wholly on the surface of the paper, which not only increases the effect of the lines, but renders it easier to make neat erasures, which is sometimes very desirable. The Chinese ink is the best. In selecting it, wet the end of the finger, and rub the ink upon it—a few seconds should suffice to give a dense, black spot—and the ink should feel perfectly smooth and free from grit; when dry, the spot should have a bright, brownish lustre; if it be dull and cloudy, reject it. Also test its adhesive power by drawing a broad black line with it. When dry, this should stand a vigorous application of the india-rubber without any tendency to smear. The lustre of the line will be diminished, but the line itself should not be erased. We have seen ink which did not smear, but yet did not adhere to the paper sufficiently to prevent the rubber from removing it in spots.

The ink is prepared for use by rubbing the end of the stick or cake in a small quantity of water in an earthen saucer—any flat-bottomed saucer, or a little common butter-plate, will do. Those who wish to purchase an outfit will find the shallow saucers sold in nests, each one being a cover to the other, as well adapted to the purpose as any thing they can find. After the ink has been mixed to a proper consistence, it should be rubbed with the finger, in order to make sure that no flake of it remains which is not thoroughly incorporated with the water. In fact, for the finest work, some insist that the cake of ink itself should not be dipped into the water at all, but simply rubbed on the wetted finger, which in its turn is to be rubbed in the saucer until the required quantity is prepared; but this takes a long time, and we consider this trouble unnecessary, if the above precaution be observed. In either case, the ink itself should be carefully wiped dry with a bit of soft paper, as otherwise it will absorb water, and this tends to make it crack and flake off when used afterwards. Also, it is well to wrap the stick up in tinfoil, leaving only an eighth of an inch exposed.

In order to tell whether the ink is sufficiently thick, draw a broad line with it, and let it dry; it should then be perfectly black. It is impossible to judge of this with certainty by the appearance of the ink in the saucer, and even a line which seems black while wet may prove not to be so when dry.

The saucer containing the ink should be covered while using it, in order to protect it from dust and retard evaporation, for which purpose a round piece of cardboard or stiff paper is most convenient.

Fig. 27.

The drawing-pen is shown in Figs. 26, 27. It consists merely of two thin blades, formed out of the same piece of steel, the elasticity of which keeps them apart, the distance being adjusted by means of the small screw, which passes through the outer blade, the inner one being tapped.

Drawing-pens are also made with the outer blade hinged or jointed to the inner one, a small spring being added to keep them apart. These are twice as costly, and not half as good, for besides being clumsy, the least wear or inaccuracy of the joint will permit a sidelong movement of one blade over the other, rendering them uncertain in their action. We speak of them only to caution any one against purchasing one; it is far better to buy two of the kind shown in Fig. 27—one of the size of the cut for fine work, the other say half as large again for the thicker lines and for coarser drawings.

The ink is introduced between the blades of the pen (the inside of which should be first dampened by breathing upon them, or, better, by passing a slip of moistened paper between them) by means of a common steel writing-pen, which should be a clean one—that is, one that has not been used with common ink. Some recommend for this purpose the use of a slip of paper, or of a small camel's-hair brush, which we mention only as a good example of bad advice.

Now, in using the pen, it should be held precisely like the pencil, care being taken to keep the edges of the blades parallel to the edge of the ruler, as, if they be dragged diagonally along over the paper, a ragged line will be the result. The pressure on the paper should be as light as possible; this will vary somewhat with the condition of the pen, as one which is dull will require more than one newly sharpened; but one which is in condition to use at all will be found to require very little more than its own weight. Beginners are very apt to overdo the matter, and bear on more heavily than necessary with both pen and pencil.

Nothing has a greater effect on the finish and general appearance of a mechanical drawing than the quality of the lines. They should be even, smooth, and sharp, and as black as jet. First-class pen-work rivals that of the engraver, and will give a neat and attractive appearance to a simple diagram; while the effect of the most accurate and otherwise elaborate drawing will be utterly ruined if the lines be ragged, uneven, pale, or carelessly joined and terminated. Considerable practice will be found necessary to gain perfect control over this simple pen and the results accomplished by it. The beginner is recommended to set the blades first for a line of medium thickness, and when he can draw smooth lines with tolerable certainty, to screw them a little closer together, and so go on until the finest lines which his instrument will make can be produced with confidence; the heavier ones, which are usually the most difficult to draw evenly, being left till the last. The beginner need not think that he is wasting paper in the repeated practice of simple exercises like those shown in Figs. 30 and 31. The paper itself need not be fine; any scrap of writing-paper which has not been wrinkled will do. Fig. 30 shows merely some rectangular figures, covered with equidistant parallel lines, horizontal, vertical, and sloping to right and left at an angle of 45°. The spacing may be done by the eye alone, or by a process which will be explained presently; and the intention is, that these shall be drawn, over and over again, of various sizes, with fine, medium, and heavy lines, until the lines of either grade can be made smoothly and uniformly. And particular attention is to be paid to the proper termination of the lines, so that they may meet and end in the outline—not stopping too soon, leaving a space, however small, or running too far, so as to project over the outline and make it appear rough. In Fig. 31, we have also a series of rectangular outlines covered with parallels, but the latter are differently disposed. In 1, the parallels make angles of 60° and 30° with the outlines, and intersect each other on the centre lines *ab*, *cd*, which should be drawn in pencil only. In 2, we have a sort of herring-bone pattern, the lines of which are perpendicular to each other and make angles of 45° with the outlines of the rectangle; the lines in which the intersections of the parallels are found, as *ab*, *cd*, etc., may also be first drawn in pencil, serving as guides in the execution of the work, and subsequently erased; they should therefore be drawn as lightly as possible—in fact, the novice will find that it is not without reason we insist so strenuously on the necessity of using the pencil lightly, in order to produce the best effect with the ink lines, for if he neglects to do so, he will soon discover that the severe use of the rubber will destroy the fresh, crisp appearance of his work. Hence we repeat, and shall repeat again, that it is better to leave out a line, if possible, than to rub it out; and if this can not be done, let the pencil line, and consequently the rubbing required to remove it, be as light as it can be made.

Among the minor faults which are very frequently met with, none is more common than that of defective intersections above alluded to, and it may be said that there is hardly one more quickly detected by the practiced eye, or more offensive to the critical one. We are therefore at the pains to illustrate these defects. In Fig. 32, A shows a right angle properly drawn, and the remaining figures of the upper row show how it very often is drawn, one or both the lines including the angle being either too long or too short. B shows a well-drawn acute angle, and is followed by similar representations of two frequent errors. These apparently insignificant things make up in a great measure the difference between well-finished and effective work, and that which appears carelessly executed and rude. And these minute defects, against which we caution the beginner with what may seem to him unnecessary care, are the very ones which first catch the eye

Fig. 30.

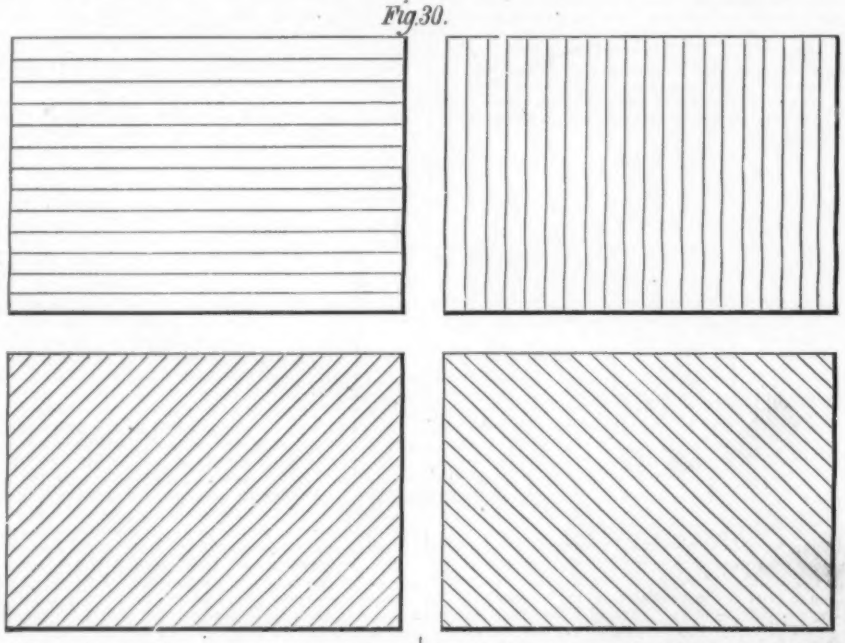
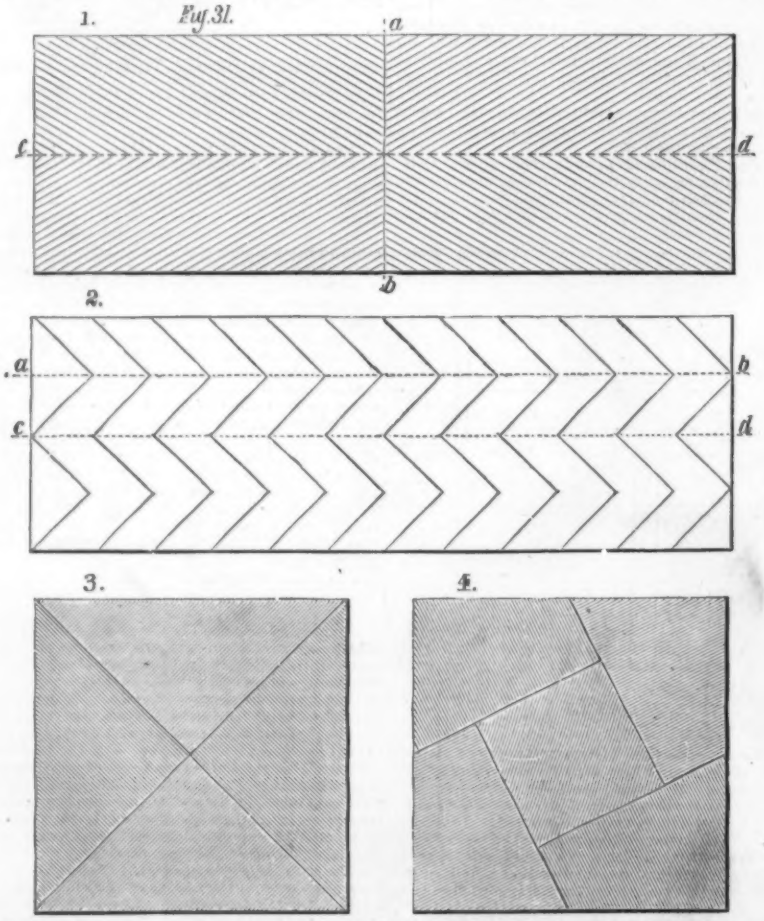


Fig. 31.



of the expert, while errors of far greater importance might be overlooked. And they hold the eye, too, when it is caught; they are like little flaws in a mirror, little cracks in a vase; and beside all this, there is one other consideration of importance: one is very apt, and with much justice, to draw the inference that he who is careless about these points of detail may be so in regard to more important things. Too much stress, therefore, can hardly be laid on the importanc of

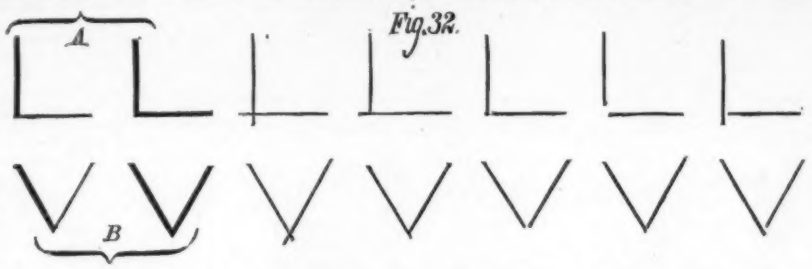


Fig.32.

forming at the outset the habit of paying attention to such matters; it will soon be done without effort, and further progress will be far more satisfactory by reason of it.

We have assumed that the majority of our readers intend to draw in ink, and are sure that all would find it more agreeable to do so, on account of the greater effectiveness, to say nothing of the permanence, of drawings so made; but the above remarks apply with nearly equal force to those which are finished in pencil only, except that less practice is required to make smooth and uniform lines. To return now to our triangles and their uses: we alluded above to a method of spacing off the outlines in Figs. 30 and 31; this depends upon the fact that a series of equidistant parallels will cut a right line which crosses them into equal parts; but the length of these parts depends on the angle at which it crosses them: if it be perpendicular to them, the parts will be of the least length possible.

Thus, in Fig. 33, the lines 1*a*, 2*b*, 3*c*, etc., are parallel; in consequence of which the divisions *ab*, *bc*, etc., of the line 0*f* are equal, and so are the others, 1-2, 2-3, etc., of the line 06; but the latter are the longer, because the first line is more nearly at right angles to the parallels than the other. Now, if 0*f* be a line which we wish to divide into six equal parts, we have only to draw another line at any angle with it through 0, and on the second line to set off six equal spaces from 0 to 6, draw the line 6*f*, and with the triangles draw through the points of division, 1, 2, 3, etc., lines parallel to 6*f*, which will give us the required points of division, *a*, *b*, *c*, etc. The spaces on 06 may be set off by means of the paper slip before spoken of, moving the edge along the line from space to space, and marking the points of division carefully with a sharp pencil. By drawing short perpendiculars below the line 0*f*, as shown, and afterwards cutting out the slip of paper S by the rectangular outline, we have a scale of equal parts. We do not pretend that this is the best way to make a scale, still it is a very convenient method at any time and under all circumstances, and enables us, with due care, to subdivide a line when no appliances for making measurements, other than those named, are at hand, with a considerable degree of accuracy.

We have observed that a great variety of pleasing figures may be made, without any addition to the inexpensive stock of instruments thus far enumerated. But in order that these,

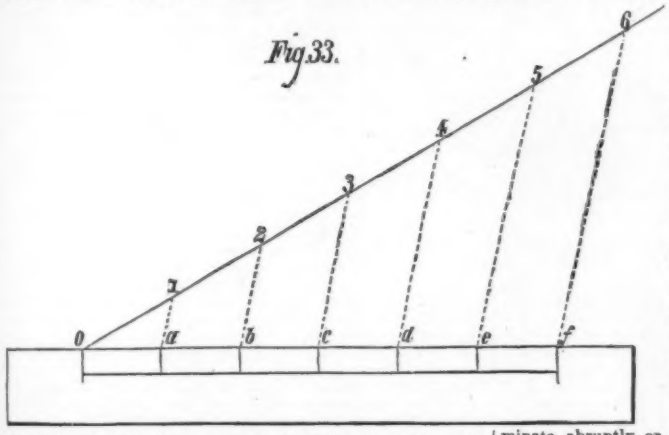


Fig.33.

of which we shall give a number, for the benefit of those who may be inclined to employ leisure moments in reproducing them as a recreation, without caring to pursue drawing in its application to machinery, may be made most effective, it is proper before doing so to explain a point which has much to do with attaining that result. We allude to the giving a drawing what is called relief, by making some of the lines heavier than others, which the attentive reader will have noticed has been done in many of the illustrations already given.

In Fig. 34, A and B are two equal squares—the first having all its outlines of uniform thickness, whereas the lower and right-hand sides of the second are heavier than the others. A glance is sufficient to show the difference in the effect. The most careless observer can not fail to see that the second stands out apparently from the paper, and evidently represents a square block of some thickness, while the first is wholly lacking in power to convey that impression. In C, D, and E, we have two concentric squares; the external one in each case has this effect of relief; but, while the central portion of C is apparently on the same level with the outer portion, that of D is just as evidently raised, and that of E depressed. To what is this due? No doubt many have noticed the fact that in all drawings which have struck them as being what is called *effective*, this difference in the thickness of the lines was quite decided, and have been in a vague way conscious of the fact that the effectiveness was dependent upon it, without stopping to think why. And even in what claim to be instructions in mechanical drawing, we have met with general orders to make the right-hand and lower outlines of a drawing heavy, "in order to give relief," without any attempt at giving a reason, and without any discrimination based on any ground whatever.

Now, let B represent a square block, with sharp corners, of any thickness, lying on the paper; and let the arrow indicate the direction in which the light falls upon it. It must be understood that the light does not come in a direction *parallel* to the paper, but, as we would naturally try to have it, from a source above the object as well as to the left. Under these circumstances, the block would evidently cast a shadow, which would fall in the direction of the light, and the edges of the block which we have made heavy in outline would be the ones which would limit that shadow, which in a tinted drawing might be itself represented. In outline-drawings we can not represent the shadows, but we can indicate their existence by this expedient of making those lines thicker which limit the shadows.

Of course, it would be out of place here to attempt the full explanation of how under all circumstances to determine what lines do cast the shadows. But this clearly depends to a great extent on the direction in which the light comes. For the sake of uniformity, then, it has been agreed to suppose its direction in all cases to be such that on the drawing it shall appear to make an angle of 45° with the horizontal line, and in the succeeding exercises it will be understood that the light comes as shown in Fig. 34.

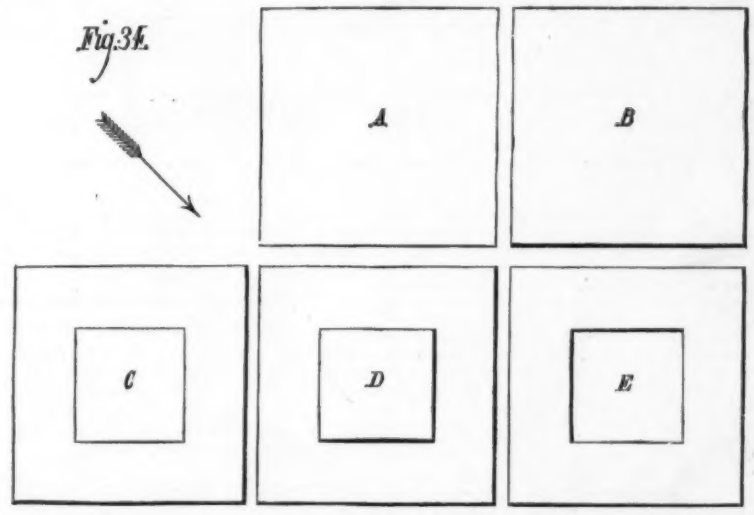


Fig.34.

We have given this explanation in this place, because we do not wish our readers to follow blindly the peculiarities of the engravings given them to copy, or in any case to do any thing without at least trying to have a reason for it. By its aid, they will, we hope, understand why it is that D in the cut indicates an elevation and E a depression: the first casts a shadow upon the surrounding surface, the last receives one from it. Fig. 35, representing a framed 60° triangle in different positions, is given as another illustration; this, as well as Fig. 34, may be copied by the student, who can readily do it without further explanation by the aid of his paper scale; and he will find, in the last especially, that care must be exercised in regard to the intersections; the angles are tolerably acute, and in joining the heavy line with the fine one, the former must not terminate abruptly or squarely, but the junction be made with a clean, sharp knife-edge, or the effect will be exceedingly bad.

(To be continued.)

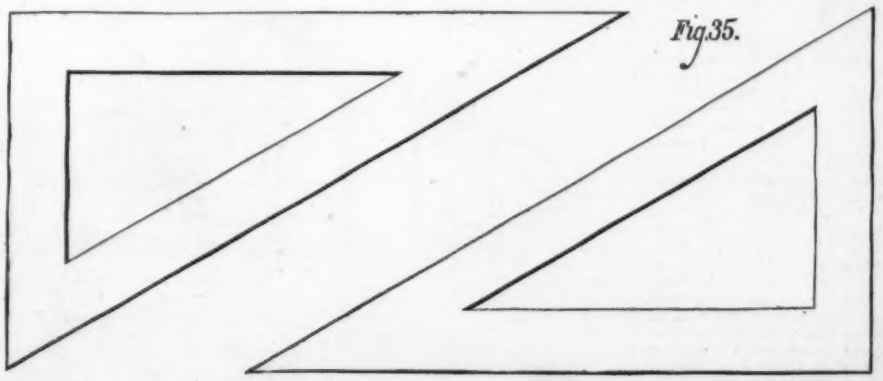


Fig.35.

SOME remains of the gigantic extinct kangaroo of Australia have recently been discovered near the city of Geelong, in the Colony of Victoria. The Geelong *Advertiser* says that this creature is believed to have attained a height of thirty feet, though it does not appear that this particular specimen was so large. The bones were found near a creek in drift fifteen feet below the present surface.

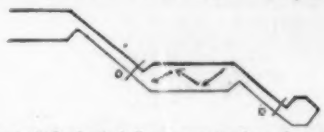
[Country Gentleman.]

TROUT-PONDS.

By J. IVES PEASE.

THE first requisite for starting a trout-pond is a clear, cold never-failing spring. It need not be large. Thousands of trout have been hatched and raised (by Mr. Ainsworth) from a stream that ran no larger than a pipe-stem. But a spring that affords from 5 to 10 gallons per minute is greatly to be preferred. The ponds for raising trout should be long (30 to 50 feet), narrow (10 to 15 feet), and deep. There should be at least three of them, for the various sizes; as, if the baby and adult fish are placed in the same pond, they will soon be all of one size—the smaller having gone down the gullets of the old cannibals—even if they are otherwise well fed. These ponds may be placed side by side, if the ground necessitates, but better end to end, or *en echelon* (as in the diagram)—so that the connecting races may have suitable fall, and the water enter the end of each pond at an angle (laterally) of about 45°, thus giving the current a zigzag direction from side to side of each pond. The *best* ponds have only earth banks, and clay, mud, or hard-pan bottoms, gravel not being desirable, as the trout are induced to spawn in it, rather than in the spawning-races. The ponds for the young fry should be 2 feet deep at the lower end, a foot less where the water enters; the second 3 to 4 feet, and the third 4 to 6 feet, as most convenient, and the water supply will warrant. The race for natural spawning should be 3 feet wide and 6 inches deep, with plank sides, placed perpendicularly, and gravel bottom, with cross-pieces to allow of their being darkened with boards or plank in the spawning season. If the Ainsworth screens are used, the lower one (with wire 8 or 10 to the inch) may be placed on the gravel bottom; and the upper one (B, or 4 to the inch) filled with coarse gravel placed over it, that the spawn may drop through and be gathered as needed. There should be screens placed *across* the various races (as at O in the diagram), to prevent the fish from running from one to the other, and at the outlet to prevent their escape. It is well to have drain-pipes laid from the bottom of each pond, that they may be drained on an emergency, and for repairs and cleaning; or a flume may be put in the outlet of the lower pond, with a movable bulkhead of strips of board placed one above another, to keep the water at the desired level.

The water of a brook may be used for raising trout, though not for hatching the eggs, unless very clear, cold, and free from sediment; and when used for either purpose, should be



brought out of the bed of the stream (unless the whole stream is turned from its channel) and ponds made on the margin, same form as where a spring is used for that purpose. If compelled to build walls for the sides of ponds, they should be laid in cement, so that the fish can find no hiding-places, and thus continue to be wild and unmanageable. A few flat stones may be placed on the bottom and sides for rubbing places, where the trout may free their sides of parasites, etc. As for "what size of ponds will be required for family use," much depends on the size of the family and how well they like trout. At Caledonia (formerly Seth Green's, now A. S. Collins') we saw, in 1872, thousands of trout in their ponds and canals, of all sizes, from fry to four-pounders; but the water supply was immense and constant. At Honeoye Falls (Fred. Mather's place) plenty of trout with a small water supply; and at Eldredge Park, Elmira, two fine ponds, 15 by 25 yards, walled up in the old-fashioned way, were a few fine trout, with but little care and a poor water supply. Seth Green writes in his "Trout Culture" that for fifteen thousand trout of various sizes in three ponds, a supply pipe 5 inches in diameter will do, but a larger one would be better.

[Land and Water.]

THE "CHAPMAN" LIFE AND SURF BOAT.

THE *Wreck Register* is by no means pleasant reading. It is not pleasing to a nation which prides itself on "ruling the waves" to be told that during the year 1873–4 no fewer than 506 lives were lost within ten miles of our coasts. But for the exertions of the National Lifeboat Institution this loss of life would have been more than doubled, as it has been instrumental in saving 713 lives during that period. Thus the importance of having the boats best adapted for life-saving purposes is very apparent, and every invention or suggestion in this direction should be carefully examined and be properly tested before being adopted or discarded. In a former number (October 16, 1875), we gave illustrations and descriptions of the lifeboats generally used by the National Lifeboat Institution, which showed how excellent they are. Nearly perfect as they are, accidents do, however, sometimes happen to them, although very rarely, and therefore, if it is possible, they should be improved, or if a better lifeboat is invented it should be adopted. There are several descriptions of lifeboats, for each of which the inventors claim perfection; but probably the only boats which have a just right to the name of lifeboats are the non-sinkable self-righting boat of the National Institution, Richardson's tubular boat, and the Chapman boat, of which we give illustrations. It is obvious that a lifeboat must possess certain qualities—it must be unsinkable, must be non-capsizable, or if capable of being capsized, must be instantly self-righting; it should be light to launch, easy to tow and row, should draw little water, and have weatherly qualities when under sail. The National Institution boat claims not to be non-capsizable, but to be self-righting. A gentleman who has for years taken great interest in saving life at sea, assures us, however, that if the crew of a lifeboat belonging to the National Institution is lashed to the thwarts, the weight is sufficient to prevent it from self-righting. Whether this is absolutely the case or not, we are unable to say, but it is evident that the weak point in this boat is the possibility of upsetting it, because even granting that it is self-righting under all circumstances, it is not always possible to secure the passengers inside, and if it was capsized, the risk of drowning must be great. Both Richardson's and Chapman's boats claim to be perfectly non-capsizable, and if this quality can be thoroughly proved their superiority can not be questioned. There are only two of Richardson's tubular boats in use, one of which has been in active service since 1856, the other since 1863, and so far both have fulfilled all the qualities claimed for them, and no accident has occurred to either. Chapman's boat has not yet received a practical trial, although it has withstood all the severe tests to which it has been subjected in a manner altogether satisfactory. The three kinds of boats are totally different in design and construction, and it may be that each possesses some peculiar and individual advantage under certain circumstances. Therefore it appears to us advisable that a proper trial—a kind of competitive examination—should be given to each, and that whichever is proved to fulfil all the required conditions, in the highest degree, should be universally adopted. Mr. Richardson has already challenged any lifeboat to compete against his; and Captain Chapman declares that it is impossible to destroy his boat under any conditions of wind and sea, and is quite willing to allow it to be put to the test and take all the risk. It therefore only remains for the National Lifeboat Institution to take the necessary steps for comparatively testing the relative merits of the different boats, and in doing this it will be adding to the good work it has already performed, and will be fulfilling the noble purpose to which it is dedicated—that of saving life at sea.

FIG. 1.

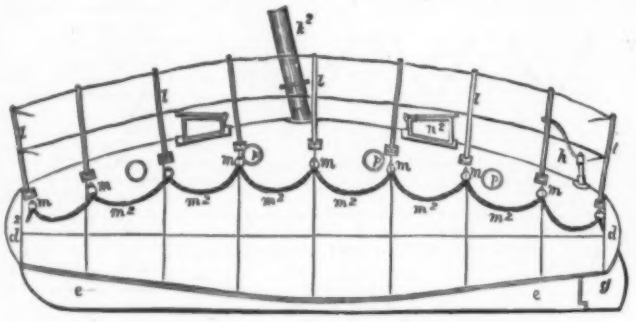
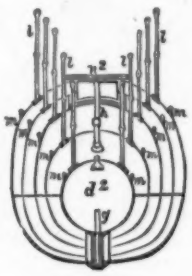


FIG. 4.

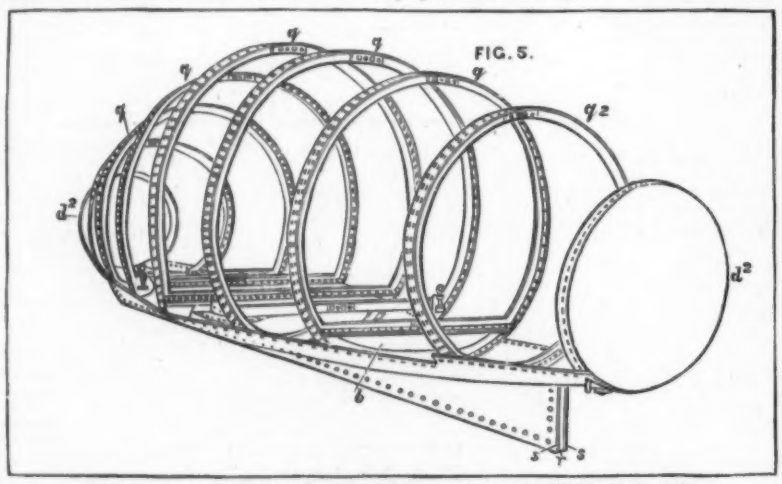


THE "CHAPMAN" LIFE AND SURF BOAT.

We here give diagrams of the "Chapman" boat, now lying in Ramsgate Harbor, which is called the Petrel. The whole structure has not much the appearance of a boat, excepting at the bottom sections, where, in Fig. 1, *e e* is the keel, which both fore and aft has a good depth and a good grip of the water. On Fig. 1, *g* is the rudder; and *d d* at either end is the convex or rounded end. M are the ring-bolts to which the lifelines are fastened; while *m*2 is the life-line. N shows a side view of the hatchways, by which two men can enter at one time in order to get down below. L shows the stanchions, through which two wire ropes are rove, to prevent any one from falling overboard. The round openings marked *p* are dead lights, large enough for a man to get his head through. H is the tiller, and h^3 the mast, which is purposely raked forward in order to throw the sail well toward the bow. On the same block (Fig. 4) is the end view of the boat, looking at her from the stern, showing the stanchions and the after parts of the after end on deck. Fig. 2 is a longitudinal section, showing the inside bands; *q* on the drawings—Fig. 6, *q* 3—is the band or rib running over the deck, under which is the water ballast; and *b* 2 and 3 in the same figure show how the T iron runs below and above the deck. *S r s* is the keel amidships, rivetted through and through; and *b* on Fig. 3 shows the section for the water ballast. Fig. 5 simply shows the ribs of T iron, and *d* 2 shows the structure of the convexed end, which is stamped out of a solid piece of sheet iron. The latter is from a photograph during the construction of her frame.

This boat, when viewed externally, has the appearance of a whale decapitated. Its total length is 25 ft. 6 in.; the height in the centre is 7 ft. 6 in. She weighs two tons. The inventor claims for her enormous stability; he says she will defy the ocean-waves, and run through the heaviest surf. She is twenty-five times stronger than an ordinary boat; she will save 150 lives in case of emergency; steam may be used in her; she may be propelled by means of oars; she sails well, and will turn to windward. She may be pitched overboard at any time crowded with people, as she can not possibly float on any other part than on her bottom for a single moment. We are authorized by the inventor to say that it is impossible to lose her in any conditions of the wind and sea.

FIG. 5.



THE "CHAPMAN" LIFE AND SURF BOAT.

FIG. 2.

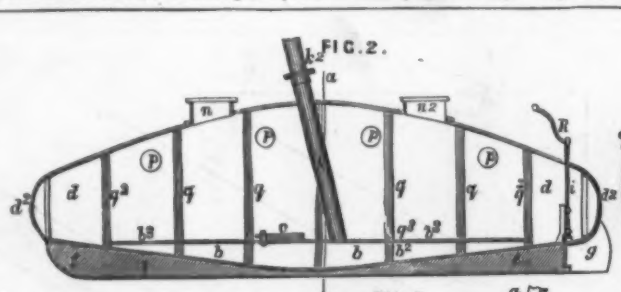


FIG. 3.

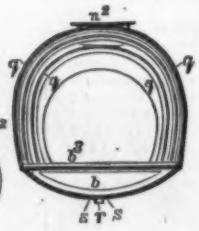
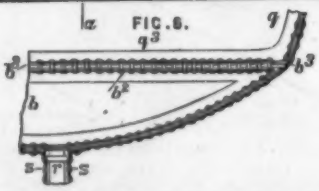


FIG. 6.



THE "CHAPMAN" LIFE AND SURF BOAT.

[Chatham Correspondence London News.]

TRIAL OF A FLYING-MACHINE.

THE new flying-machine, the invention of Mr. Simmonds, and intended for use in military operations, was subjected to a public trial by the inventor on Chatham lines, December 15th, the experimental trial being attended by a large number of the officers of the Royal Engineers, among whom were Major V. G. Clayton, Secretary of the Royal Engineer Committee, Captain M. T. Sale, one of the instructors in field fortifications, and other heads of departments connected with the School of Military Engineering. A number of non-commissioned officers and men of the Royal Engineers had been placed at the disposal of Mr. Simmonds, to assist him in carrying out the experimental trials. The machine, which may be said to consist of two independent parts, is nothing more than a huge, square-shaped, light canvas covering, stretched on four slight but strong ash-poles, or arms placed at right angles to each other, the covering being further attached to a centre pole—resembling nothing so much as the handle of an enormous umbrella—by means of light galvanized wires, the entire machine being in appearance an enormous, square-shaped umbrella, the largest of the two parts, or, more properly, machines, weighing about one hundredweight, and the other, which is smaller, somewhat less. From the extremities of each of the four arms is attached a rope of considerable length, the four ropes being brought to a point—somewhat similar, in this respect, to a parachute—so as to support a man, the machine being intended for reconnoitring observations in connection with an army in the field. During the experiments, sand-bags were employed to represent the weight of a man. The smallest of the two machines was first tried, but owing to there being little wind, it attained an elevation of but a few feet only, a number of sappers of the Royal Engineers running away with the rope to which the machine was attached, much in the same way as that adopted by children when flying their kites. After repeated attempts in this way, Mr. Simmonds only succeeded in inducing the machine to rise to about twenty feet, when it would immediately fall with great force to the ground. After some time spent in these fruitless efforts, which occasioned much impatience among the spectators, it was decided, at the request of the royal engineer officers present, to try to raise the largest of the two machines, which had been lying during the former part of the experiments in the centre of Chatham lines, where it had been swaying backwards and forwards with the little wind blowing. The same method of raising the larger machine as that adopted in the previous experiments was again employed—a number of men of the Royal Engineers being stationed at the end of the rope, about three hundred yards away, the machine itself being held up to face the wind by several other sappers. At a given signal from Mr. Simmonds, a run by the men was made, when the machine rose to a height of about fifty or sixty feet, and then came to the ground. A readjustment of the four guiding-ropes and wires having been made, a further attempt to raise the machine was tried; but although an altitude of rather more than one hundred feet was obtained, the flying-machine obstinately refused to remain in the air, but fell with a crash to the ground, breaking one of its four-arm poles, and sustaining other damage. The cause of the collapse of the machine was stated by Mr. Simmonds to have been occasioned by the ballast attached to it not being of sufficient weight, and the four ropes which were connected with the ends described not being of the proper length. After a consultation, it was decided to abandon any further trials on the occasion with the large machine, as some time would be required to substitute a new arm-pole for that broken, and the machine was at once stripped of its canvas covering. A second series of attempts to raise the smaller of the machines was then made, but with little or no better results than those previously achieved, and, after upward of two hours had been consumed in carrying out the trials, the experiments were for the present abandoned.

THE RAILWAY-BRIDGES IN LONDON.

AMONG the numerous private bills to come under the consideration of Parliament during the ensuing session is one of a very important character as affecting the railway-bridges within the metropolis. The bill is promoted with a double object. One is preventing the percolation of water through the bridges, from the railway level to the thoroughfares beneath them, which, for several years past, has been a source of much inconvenience and annoyance to pedestrians, as well as to carriage traffic. The other object is to compel the adoption of measures for deadening the unpleasant noise caused by the trains passing over the bridges, which has been abundantly proved, amongst other evils, to be dangerous to equestrian and vehicular traffic. Within the metropolitan area there are several hundred bridges of this character, the larger proportion being south of the Thames, and connected with the South-Eastern, the London, Chatham and Dover, the London, Brighton, and South Coast, and the South-Western companies respectively; but there are likewise several in other districts belonging to the London and North-Western, Midland, Great Northern, and Great Eastern companies. It has been ascertained that both the prevention of the leakage through the arches of the bridges and the noise caused by passing trains can be effected, but although efforts have been made by the local authorities to induce the several companies to remedy the evil, they have, with the exception of a few instances, been unsuccessful. The provisions of the bill arm them with greater powers over the companies than those which they at present possess. It contains clauses empowering the several vestries, district boards, and other local authorities to compel the railway companies to execute works at their bridges for securing both the objects named, and in the event of their failing to do so after due notice given, the vestries are to be at liberty to do the work themselves, and to charge the railway companies with the cost.